Remedial Investigation & Alternative Analysis Work Plan

136 Fuller Road Site
Brownfield Cleanup Program
NYSDEC Site No. C401055

City of Albany and Town of Guilderland
Albany County, New York

June 2010

Chazen Project No. 90618.00

THE Chazen COMPANIES®
Engineers
Environmental Professionals
Land Surveyors
Landscape Architects
Planners

Prepared for:

Fuller Partners, LLC
PO Box 370
133 Route 395
East Chatham, NY 12060

New York State Department of Environmental Conservation – Region 4
1130 N. Westcott Road
Schenectady, New York

Prepared by:

Capital District Office:
The Chazen Companies
547 River Street
Troy, New York 12180

I certify that this Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER10).

QEP: Mr. Dan Stone, PE

Hudson Valley Office
(845) 454-3980

North Country Office
(518) 812-0513

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1.0 INTRODUCTION

This Remedial Investigation and Alternative Analysis Work Plan (Work Plan) outlines the components of supplemental site investigation activities which will be implemented to evaluate and delineate the type, distribution, and magnitude of contamination that have been identified at the 136 Fuller Road Site ("site") in accordance with the New York State Department of Environmental Conservation (NYSDEC) Brownfields Cleanup Program (BCP). The Fuller Partners, LLC application for the BCP program was approved by the NYSDEC and the site's BCP number is C401055. This Work Plan is presented to supplement data collected and reported in a 2007 draft remedial investigation report and also proposes an Interim Remedial Measure (IRM) that will be conducted during the investigation phase.

The site is a 15.72-acre property located at 136 Fuller Road in the City of Albany and Town of Guilderland, Albany County, New York. The site is currently developed with a 266,000-square foot commercial/industrial, single-story building which is predominately occupied by UltrePet LLC, recyclers of plastic polyethelene (PET) bottles and manufacturer of PET plastic resins. The site is also occupied by Equal Vision Records, a T-shirt silk screening printer. The remaining portion of the site building is vacant and unused warehouse space. Crown Castle International currently leases a 0.06 ± acre portion of the northeastern site area for the location and operation of cellular telecommunications tower, antenna and associated equipment (Crown Castle Site # 806676). The property is identified on the Albany County Real Property Tax Map as Parcel #52.8-2-1. Figures 1 and 2 of this report illustrate the site location and features.

A 2007 initial remedial investigation was conducted before the site became part of the BCP. The 2007 draft remedial investigation report concluded that VOCs, primarily the chlorinated solvent tetrachloroethylene (PCE) and degradation products, are present in site soil and groundwater at concentrations greater than the regulatory cleanup standards. The source area was identified as the former tank farm and the contaminant plume was identified beneath the building. While sub-slab soil gas samples indicated the presence of VOCs beneath the building, indoor air quality testing showed no evidence that VOCs have migrated through the building slab at concentrations that adversely affected air quality in the building.

This Work Plan outlines the approach to further characterize the extent of soil and groundwater contamination and geologic conditions such that remedial alternatives can be developed and assessed. Areas to be investigated include the identified PCE source area and the plume area. The site will be investigated for the full target compound list of contaminants that consists of VOCs, semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals. Contaminants that exceed regulatory cleanup standards are identified as contaminants of concern (COCs). The distribution, persistence, and fate of the full target compound list of contaminants and their impact on the intended future use of the site and the environment will be the subject of this remedial investigation.

Remedial alternatives will be evaluated based on data comparison of analytical results to NYSDEC soil cleanup objectives and groundwater quality standards. Upon completing the work proposed herein, Chazen will present the data and findings to NYSDEC with a remedial

alternatives analysis. Additionally, this Work Plan details the planned Interim Remedial Measure (IRM), consisting of the design and installation of a Sub-Slab Depressurization System (SSDS) in building areas overlying the VOC plume, to eliminate the potential for VOC migration into the site building.

1.1 Work Plan Organization

This Work Plan contains historic site information, summarizes findings of previous investigation activities, and outlines the proposed on-site investigation activities. The background information has been provided to supply the reader with the rationale of the proposed activities (Section 2.3 and 2.4). Subsequent sections describe the approach that will be undertaken to complete the remedial investigation and alternatives analysis as indicated. Details of the sampling activities (e.g., media, sample location, frequency, and analyses) are provided in the Field Sampling Plan (FSP) attachment to this Work Plan.

- Section 2.0 – Site Description and History – describes the physical and environmental setting of the site with a summary of previous investigations.

- Section 3.0 – Work Plan Objectives, Scope and Rationale – describes the objectives and rationale for the scope of the investigation including the IRMs and soil and groundwater investigation activities. Details of the proposed sampling are described in the Field Sampling Plan attachment to this Work Plan.

- Section 4.0 – Data Reduction and Reporting - details the data assembly, data reduction/evaluation, and remedial alternative evaluations.

- Section 5.0 – Schedule – provides a sequencing schedule for the proposed field work, data reduction and subsequent reporting.

- Section 6.0 – FSP, QAPP, HASP, CPP, CAMP and IRM- outlines the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), Health and Safety Plan (HASP), the Citizen Participation Plan (CPP), Community Air Monitoring Plan (CAMP), and Interim Remedial Measures (IRM) Work Plan. The above-listed plans are included in the appendices of this document.

1.2 Project Organizational Structure

This project will involve the coordinated efforts of The Chazen Companies (Chazen), its subcontractors, and key government contacts. The key personnel to the project are listed below.

Project Principal – Daniel Stone – Mr. Stone is a principal partner of The Chazen Companies and is responsible for establishing contracts for services to be performed and will provide corporate level input for problem resolution. Mr. Stone is the Qualified Environmental Profession for this project.

Project Manager – Kim Baines – Mr. Baines will be responsible for establishing protocols to be used during the investigation and remedial activities, and establishing sampling methods. He will provide oversight and technical guidance during field activities and report preparation, maintain quality and consistency, and monitor the overall work progression and quality and content of deliverables.

Assistant Project Manager – Arlette Meader – Ms. Meader will be the primary contact with the NYSDEC. She will be responsible for task-specific budgeting and scheduling. She will monitor the overall activities, confirm implementation of established protocols, and schedule and coordinate investigation and reporting phases of the project.

Field Operations Leader– Scott Dietzel – Mr. Dietzel is an experienced project geologist will be responsible for executing the scope of work. During field activities, he will be the liaison among field staff, subcontractors, and on-site representatives from NYSDEC and NYSDOH.

Quality Assurance Officer (QAO) – Stephen Myers – The QAO will assist the project manager in the development of the sampling and analytical portion of the QAPP. The QAO, or a designee, shall conduct periodic field and sampling audits as needed, and interface with the analytical laboratory as needed.

Health and Safety - Kim Cuppett – The Health and Safety Officer will be responsible for review and approval of the site-specific Health and Safety Plan and ensuring that throughout the duration of the field activities all aspects of the Health and Safety Plan will be complied with. Ms. Cuppett will have authority to stop work should unacceptable health and safety risks occur.

Subcontractors - Subcontractors will be selected based on competitive bid and qualifications. All subcontractors will be required to comply with necessary Federal and State training regulations and comply with all applicable regulations for safely performing the job. Subcontractors working on the site will be responsible for preparing their own site-specific Health and Safety Plan (HASP). Chazen will provide the NYSDEC and Fuller Partners LLC information regarding the subcontractors used on this project as prescribed by the NYSDEC.

Fuller Partners LLC Representatives – Ed Hoe and Leigh Peritz – Mr. Hoe and Mr. Peritz are the points of contact for the Fuller Road site.

NYSDEC – Bradley Brown – Mr. Brown will be the NYSDEC Project Manager and point of contact for the Department of Environmental Conservation from the Schenectady NYSDEC Region 4 Office and will be responsible for the State approval of this Work Plan and Interim Remedial Measures.

Contact information for the principal project personnel is provided in the following table. Qualifications for the Chazen personnel are provided in Appendix G.

Name	**Role, Organization** **Mailing Address**	**Phone Number(s) and Email**
Mr. Bradley Brown	Project Manager, NYSDEC 1130 North Westcott Road Schenectady, NY 12306-2014	518-357-2145 bxbrown@gw.dec.state.ny.us
Mr. Kim Baines	Project Manager, CEA 950 New Loudon Road Suite 340 Latham, NY 12110	518-783-1700 office Kbaines@cea-inc.com
Ms. Arlette Meader	Assistant Project Manager, Chazen 547 River Street Troy, NY 12180	518-266-7328 office ameader@chazencompanies.com
Mr. Scott Dietzel	Field Operations Leader, Chazen	518-266-7314 office sdietzel@chazencompanies.com
Mr. Ed Hoe	Owner, Fuller Partners LLC PO Box 370 1133 Route 295 East Chatham, NY 12060	(518) 392-0557 ehoe_hoeassociates@taconic.net
Mr. Leigh Peritz	Owner/Facility Contact, wTe Corporation 7 Alfred Circle Bedford, MA 01730	(781) 275-6400 lperitz@wte.com

2.0 SITE DESCRIPTION AND HISTORY

A summary of background information for the site follows and contains a site description, site history, the area geology and hydrogeology, and known and suspected areas of concern. This information provides the basis for developing the sampling approach. This section of the Work Plan also summarizes data and reports from relevant documents obtained from the NYSDEC.

2.1 Site Location

The 136 Fuller Road site is a 15.7 ± acre industrial property situated on the eastern side of Fuller Road. The current zoning for the property is C-M; this is a light manufacturing district. Located approximately 450 feet south of the intersection of Fuller Road and Railroad Avenue, the site is situated predominantly in the City of Albany, Albany County, NY with less than 0.5 acre situated in the Town of Guilderland, Albany County, NY. A map illustrating the site location is attached as Figure 1.

2.2 Property Uses (Historic, Current and Future)

The site was developed circa 1955 as the Mohawk Brush Company which produced brushes for the Fuller Brush Company. The Mohawk Brush Company/Fuller Brush Company owned and operated at the site for approximately 20 years until the mid-1970s. From the mid-1970s, Star Textiles activities at the site included manufacturing poly-fill material and plastic resin from

recycling plastic. In 1990, wTe Recycling Corp. acquired Star Textiles and operated a plastics recycling business. In 1999, wTe Recycling Corp. entered into a partnership agreement with Tomra of North America called UltrePET LLC. UltrePET LLC continues to operate a plastics recycling business at the site.

The site is currently developed with a 266,000-square foot commercial/industrial, single-story building which is predominately occupied by UltrePet LLC. Figure 2 is a boundary survey that shows the property and the site building. The eastern side of the site building is occupied by Equal Vision Records, a T-shirt silk screening printer. The remaining portion of the site building is vacant commercial/industrial warehouse space. Crown Castle International currently leases a 0.06 ± acre portion of the northeastern site area for the location and operation of cellular telecommunications tower, antenna and associated equipment (Crown Castle Site # 806676).

The proposed future use will provide needed services and support for the neighborhood by providing a mixed use of office space, restaurant and hotel development. This usage will enrich the community by bringing in occupants that will support neighboring businesses.

2.3 Environmental Setting

This section provides information on the site geology, soils, hydrogeology, surface water resources, and land uses in the site vicinity.

2.3.1 Geology

The geology of the area is shaped by the glacial history of New York State. Approximately 20,000 years ago in the Wisconsinan Era, New York State was covered by a glacier that extended south to present day Long Island. As the glacier began to melt, it receded northward toward present day Albany. As the glacier receded, the melt water was blocked by ice and glacier moraine deposits and formed glacial Lake Albany. Lake Albany spanned from the present day Glens Falls region south to present day Newburgh. The Mohawk River emptied into Lake Albany forming a large delta formation and depositing large amounts of sand and gravel. In addition to the sand and gravel deposits, glacial lakes also deposited very fine grain material that settled out in clay layers to form the lake bottom. The sand, gravel and clay deposits are characteristic of the site area.

A review of the *Geologic Map of New York, Hudson-Mohawk Sheet* (1970) indicates the bedrock in the area of the subject property is mapped as Normanskill Shale which consists of minor mudstone and sandstone. Bedrock was not encountered in the borings installed during this investigation, the deepest being 40 feet below the ground surface.

According to the Natural Resources Conservation Service (NRCS), the majority of the soil on site is mapped as Udipsamments or Smoothed and Urban Land. Soils classified as Udipsamments are described as consisting of coarse sand and are well-drained. Soil classified as Smoothed and Urban Land is described as consisting of a variable texture whose drainage class is not reported.

A review of the *Surficial Geologic Map of New York-Hudson-Mohawk Sheet* (1989) indicates that the soils in the area of the subject property are mapped as lacustrine sand. Sand deposits are typically associated with large bodies of water, generally a near-shore deposit or near a sand source. Lacustrine sand soils are well sorted, stratified, and generally consists of quartz sand with a variable thickness of 2 to 20 meters.

Soil encountered during drilling activities primarily consisted of silty sand. Clay was also found in some of the shallow borings completed on the northern side of the building and northern interior locations. A clay layer was encountered during the installation of monitoring wells MW-1, MW-3 and MW-5 at approximately 31-ft, 36-ft, and 30-ft below the ground surface, respectively. The clay layer encountered at depths equal to or greater than 30-feet is interpreted to be a continuous, naturally-occurring clay layer, and there are shallow clay intervals encountered discontinuously at depths less than 20 feet.

Silt and fine sand was present throughout the site, and the difference between shallow fill and naturally occurring sand layers was difficult to distinguish. There appeared to be a slight fining downward gradient in the deepest borings. A copy of a site development plan showing locations of cut and fill areas at the site is provided for reference as Figure 4.

2.3.2 Hydrogeology

Based on a survey of static water elevations in site wells, shallow groundwater on the site flows to the south (as shown on Figure 2). Groundwater elevations are relatively flat in the north and west areas of the site. The gradient increases as groundwater approaches the Patroon Creek to the south and east. The elevation stage of the Patroon Creek in comparison to the groundwater elevations approaching the creek indicate that the two intersect.

In the area of the former tank farm, local groundwater elevations appear to be influenced by the presence or absence of discontinuous shallow clay deposits in the subsurface which create sharply contrasting differences in the potentiometric groundwater surface elevations between adjacent clay and sand units. Monitoring wells MW-19 and MW-24 installed in the clay unit were measured as having much higher groundwater elevations, from 2 to 6 feet higher that the rest of the wells in this area which were installed in the sandy soil unit.

No hydrogeologic information was available for properties which surround the subject site. Based on a review of available information, regional drainage and shallow groundwater flow in the area of the subject site is expected to mimic surface topography and be southward towards the Patroon Creek.

2.3.3 Surface Water Resources

The closest surface water body to the site is the Patroon Creek. The south branch of the Patroon Creek originates from Lake Rensselaer approximately 1,100 feet west of the site. The Patroon Creek flows in an easterly direction near the south side of the subject property and flows approximately six miles east to the Hudson River.

The original building plans for Mohawk Brush Company show that the Patroon Creek was relocated from its original location during the original 1955 site development process (see Figure 5). The creek, which meandered in the southern portion of the property, was diverted to a more direct route via a culvert that directed the water from Lake Rensselaer at Fuller Road farther south of the site. Currently the creek runs underground by way of culverts south of the site and through the NYS I-90 Highway Fuller Road exit ramp property. Culverts direct the stream flow from Fuller Road eastward beneath the highway exit ramp system. Just south of the central area of the site, one of the stream culvert sections surfaces to a small surface water area then re-enters another culvert, traverses beneath another section of the exit ramp and then discharges to the exposed stream valley east of the exit ramp and east of the site property. Creek exposure nearest the property is south of the central portion of the site, in a surficial drainage depression area between the site and the I-90 Highway exit ramp.

2.3.4 Land Uses Within 1,000 Feet of the Site

Prior to 1955, the subject site was undeveloped land. Based on historic photos, the surrounding area appeared to be cultivated agricultural property. The subject site was developed in 1955 for commercial and industrial use by the Mohawk Brush Company. Properties located to the north and east of the site are presently, and have historically been, utilized for commercial and industrial business along a heavily industrialized rail corridor. Figure 3 shows land uses within 1,000 feet of the site.

Railroad Avenue lies north of the Conrail railroad and is an industrial corridor served by the railroad. To the west of the site are Lake Rensselaer and a recreational public park. The Interstate 90 Highway and a highway access ramp are south of the site.

2.4 Environmental History

2.4.1 Summary of Previous Investigations

VOCs identified at the site include tetrachloroethylene (PCE), also called perchloroethylene, and PCE degradation products. PCE has not been documented as a chemical used in the former brush manufacturing process and the source of PCE is currently unknown. The PCE source area has been identified beneath the eastern side of the former tank farm and extends under the northern edge of the site building. The contaminant plume area has been identified beneath the site building. Figure 2 depicts PCE concentrations in the source area and the plume area.

Contaminants identified in soil exist at highest concentrations from the top of the groundwater table at 8 to 10 feet below ground surface to a depth of 16-20 feet below ground and then diminish rapidly below this depth (typically occurring in the top 10 feet of the shallow groundwater table).

A summary of previous environmental investigations that have occurred at the site is as follows.

- A 1988 *Phase I Environmental Site Assessment (ESA) Report* noted that five underground storage tanks (USTs), reportedly containing No. 6 fuel oil, pine oil, soaps, and water were removed from the northeast side of the site building in the spring of 1988. Information indicated that a small amount of pine oil leaked from one of the tanks during removal and contaminated soil was removed during the tank closure.

- A 1996 *Phase I ESA Report* identified the presence of two 16,000-gallon USTs for fuel oil located near the boiler room south of the site building. These USTs were removed in October 2003. Post-excavation soil samples did not exceed applicable NYSDEC soil quality standards.

- A 2004 *Phase I ESA Report* identified a number of potential contaminant sources on the site property, most of which were part of the former brush manufacturing operations by the Mohawk Brush Company/Fuller Brush Company. Petroleum based products, pine oils, alcohols and freon had been stored in both underground and above ground tanks along the northern side of the site building in a historic bulk storage "tank farm."

- A 2007 investigation included sampling of soil, shallow and deep groundwater, and sub-slab soil vapor. Findings are summarized below and Figure 2 shows boring/well locations. That initial remedial investigation was conducted in response to Spill #0503855, and data collected as part of those sampling activities will be incorporated into the Remedial Investigation that will be conducted under the BCP, which is the subject of this Work Plan. The 2007 draft remedial investigation report is included in the public repository BCP documents.

    - The contaminants of concern identified at the site were chlorinated compounds (PCE and degradation products) and some petroleum-related compounds. The PCE source area, where substantially impacted soil was identified, is beneath the eastern side of the former tank farm and extends under the northern edge of the site building. The chlorinated solvent plume extends beneath the site building where groundwater impacts were identified but soil impacts were less than those in the source area. Petroleum-related compounds, including methyl tert-butyl, were found at low concentrations at various locations at the site, suggesting they entered the groundwater flow regime at sufficient distance to allow it to settle and widely disperse.

    - The highest level of soil and groundwater contamination exists at a former tank farm area on the north side of the building (formerly present during the Fuller Brush Company operations). From the tank farm area and south, contamination is predominantly present in the top ten feet of saturated soil and groundwater, which is first encountered between 8 and 10 feet below the ground surface.

    - Sub-slab sampling results indicate that soil vapor contamination exists beneath the building slab. The potential for soil vapor intrusion into the building exists as a result of the continued presence of impacted soil vapor; however, sampling

performed in December of 2006 did not identify migration of these chemicals into the indoor air. Venting beneath the building is currently being proposed to eliminate this potential soil vapor exposure pathway.

2.4.2 Known and Suspected Areas of Concern

Two areas of concern (AOCs) have been identified and will be addressed at the site: the PCE source area and the plume area (see Figure 2).

1) The contaminants identified at the site are the VOCs PCE and its degradation products. The source area (where substantially impacted soil was identified) has been identified north of the building on the eastern side of the former tank farm area and extends under the northern edge of the site building.

2) The PCE groundwater contaminant plume extends beneath and to the southern site of the site building.

This remedial investigation will include additional soil borings and groundwater monitoring wells to supplement and further define the extent of the soil and groundwater impacts, characterize soil and groundwater within the plume to assess potential remedial alternatives, and to further assess geologic conditions at the site.

3.0 WORK PLAN OBJECTIVES, SCOPE AND RATIONALE

3.1 Interim Remedial Measures Objective and Rationale

The IRM objective is to perform reasonably anticipated measures that may be warranted to prevent migration of VOCs into the site building. Despite the lack of VOCs in the indoor air samples, several of the sub-slab soil gas samples identified VOCs beneath the site building at elevated levels that trigger the NYSDOH to recommend that measures be taken to mitigate the migration of vapors from beneath the building into the building interior spaces. Due to the lack of measurable VOCs within the building's airspace, this is proposed as a protective measure to prevent potential off-gassing of VOCs into the building's workspace both from existing VOC plume and from any conditions that may arise during soil and groundwater remediation beneath the building. To accomplish this objective, this Work Plan proposes the installation of a sub-slab depressurization system (SSDS) beneath the building. The IRM Work Plan is included as Appendix F and provides details of a SSDS pilot study, design, and installation.

The SSDS will initially be designed and installed over the identified groundwater plume footprint, and then sub-slab soil vapor samples will be collected incrementally outward from the plume area to document horizontal extent and determine if the SSDS needs to be expanded.

3.2 Investigation Objective and Rationale

The remedial investigation objective is to fully define the nature and extent of contaminant impacts to soil and groundwater for use in fate/transport assessment and to gather additional geologic and groundwater information for use in evaluating appropriate remedial methods and designing a remedial action.

Investigation objectives will be met through the collection and field screening and laboratory analysis of soil and groundwater samples for contaminants of concern and physical and biological characteristics. Media will be initially evaluated within the identified source areas, the plume area, and a down gradient location. The FSP (attached as Appendix A) provides a detailed discussion of sample location/frequency and laboratory analyses. The conceptual site model of the concentrations and distribution of contaminants of concern (COCs) will be defined, and then data will be evaluated to assess the potential necessity for further studies and develop appropriate remedial action responses relative to NYSDEC BCP objectives. All field work outlined below, including project documentation, will be completed in accordance with the FSP, HASP, CAMP and QAPP which are described later in this Work Plan and also provided as appendixes.

This Work Plan has been prepared to be consistent with the general requirements of the NYSDEC Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation (DER-10, Draft November 2009) and Brownfield Cleanup Program Guide (May 2004).

In order to meet the project objectives, the following tasks will be implemented:

- Conduct soil and groundwater sampling to fill data gaps and define the conceptual site model for the tetrachloroethylene (PCE) source area using shallow borings/wells and further delineate the clay layer with deep borings/wells (i.e., to the underlying clay layer). Soil samples will be field screened for VOCs using a portable gas chromatograph and a photoionization detector.
- Install and sample shallow borings/wells inside the building to further define the PCE contamination plume and determine if the storm drain corridor is acting as a conduit for contaminant migration.
- Install deep borings on the south side of the building to further investigate the site geology with respect to confirming the presence of a deep (30-35 foot) clay layer.
- Sample existing groundwater monitoring wells.
- Analyze samples for contaminants of concern (COCs) and additional physical and biological parameters to provide sufficient data to evaluate proposed remedial technologies.

Fuller Partners LLC is implementing this work to assess the existing environmental site conditions and to ultimately perform environmental remediation to remediate the site to acceptable regulatory standards.

A designated number of samples will be collected from each area of concern, as specified in the FSP. Samples will be analyzed for the contaminants related to the source material, as defined in the FSP. Samples will be shipped to a New York State Environmental Laboratory Approval Program (NYS ELAP) certified laboratory for analysis. Level B deliverables will be generated so that data are sufficient to make decisions regarding the need for further investigation.

3.3 Soil Gas and Vapor Intrusion Surveys

Following SSDS installation over the groundwater plume, sub-slab soil vapor samples will be collected incrementally outward from the plume area to document horizontal extent and determine if the SSDS needs to be expanded. Soil vapor data will be compared to the appropriate NYSDOH matrices that have recently been updated to include additional chemicals.

3.4 Ecological Investigations

The site is located in a light manufacturing district zoned area. The majority of site ground surface is occupied by the site building or paved with some intermittent areas of vegetation primarily consisting of grass lawn areas. Based on nearby surface water sampling conducted during the 2007initial investigation and extensive sampling of Patroon Creek in 2003, no ecological impacts have been identified in Patroon Creek and it appears that effluent discharges from the site plume, if any, are not likely to adversely affect media within the creek system. Therefore, a Fish and Wildlife Resources Impact Analysis will not be conducted. A summary of these investigations follows.

- In 2003 a remedial investigation was performed at the Mercury Refining Site at 26 Railroad Avenue in Albany (east of the subject site) and included an extensive evaluation of the Patroon Creek. The report references several studies performed in the late 1980s and early 1990s. The studies included sampling and analysis of surface water, sediment, fish and benthic invertebrates in the creek at locations both downstream of the subject property and upstream and in the reservoir at the headwaters of the creek. These studies included analysis for PCE and TCE and concluded that there were no significant impacts to the stream from VOCs (including the VOCs identified on the subject site) and no VOC impacts at levels above standards for fish or invertebrates within the stream.

- During the 2007 investigation, off-site surface water samples were collected and analyzed for the presence of VOCs and SVOCs. No evidence of upstream or downstream impacts was identified and the 2003 study findings were confirmed.

4.0 DATA REDUCTION AND REPORTING

4.1 Remedial Investigation

Following completion of the field work and laboratory analysis, laboratory analytical data will be submitted to a third party data validator that will conduct data validation and prepare a Data Usability Summary Report (DUSR) for the laboratory data. Validated analytical results from each of the investigated media will be compiled and compared to applicable standards, criteria, and guidance (SCGs). This information will be evaluated to define the existing conceptual site model for contaminants of concern. Should this evaluation reveal significant data gaps, then a determination will be made whether to proceed with collection of additional data. It is anticipated that the NYSDEC, Chazen, NYSDOH, and Fuller Partners LLC would discuss identified data gaps and negotiate the proposed remedy (e.g., data collection via additional field work).

Once completed, the findings and recommendations will be assembled into a Remedial Investigation (RI) Report. The RI Report will be prepared according to DER-10 Section 3.14 and will supplement information presented in the 2007 draft remedial investigation report. The RI Report will address the following data gaps identified by NYSDEC and NYSDOH and in doing so will complete the remedial investigation process will include the following components:

1. Describe IRM activities and results (see Section 4.1.1 below).
2. Gather additional geologic information regarding shallow pockets of clay and the deeper continuous clay layer.
3. Further investigate the source and plume areas to evaluate physical and biological characteristics for use in developing and analyzing remedial alternatives.

4.1.1 Interim Remedial Measures

The planned site IRM is the installation of a Sub-Slab Depressurization System (SSDS) beneath the building in the area of the contaminant source and plume. A description of the IRM activity will be included in the RI/AA report. A summary of the system design pilot study, system design, installation, and operations will be provided.

4.1.2 Data Reduction – Soil

Soil samples identified in this Work Plan and Field Sampling Plan, which will be collected under the BCP, will be used to supplement the 2007 investigation samples. Collectively, the laboratory analytical data and field screening measurements will be reviewed, compiled into data tables, and laboratory data will be compared to soil SCGs. The 6 NYCRR Part 375 soil cleanup objectives will be used for soil SCGs. Soil samples that exceed the SCGs will be plotted on a site plan to assist in the visualization of the distribution of contaminants. The data will be used to further define the conceptual model of the site.

4.1.3 Data Reduction – Groundwater

Groundwater samples identified in this Work Plan and Field Sampling Plan, which will be collected under the BCP, will be used to supplement the 2007 investigation samples. The laboratory analytical data will be reviewed, compiled into data tables, and compared to groundwater SCGs. The Part 703 groundwater quality standards will be used for groundwater SCGs. Groundwater samples that exceed the SCGs will be plotted on a site plan to assist in the visualization of the distribution of contaminants. The data will be used to further define the conceptual model of the site.

4.1.4 Data Reduction – Soil Vapor

Soil vapor samples identified in this Work Plan and Field Sampling Plan, which will be collected under the BCP, will be used to supplement the 2007 investigation samples. The laboratory analytical data will be reviewed and compiled into data tables. The State of New York does not have SCGs for soil vapor. Sub-slab soil vapor data will be compared to NYSDOH matrices identified in the Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006).

4.1.5 Water Well Survey

A drinking water well survey was performed as part of the 2007 investigation. As the surrounding properties are connected to the municipal water supply system, no additional water well survey will be conducted.

4.1.6 Fate and Transport

Laboratory data will be combined with the groundwater flow direction data to further define the anticipated fate of identified COCs. Natural attenuation parameter data will be collected to further characterize the contamination and define the data set. The results will be used to evaluate appropriate remedial alternatives.

4.1.7 FWRIA

Based on ecological data compiled during the 2007 initial remedial investigation, as presented in Section 3.4, no off-site ecological impacts have been identified and no FWRIA is planned.

4.2 Alternatives Analysis

Once the data interpretations are completed, remedial alternatives to address soil and/or groundwater contamination will be developed. The Alternatives Analysis will be prepared according to DER-10 Section 4.3 and will include the following components:

1. Present remedial action goals
2. Present remedial action objectives

3. Identify general response actions
4. Identify and screen remedial technologies for media and contaminants that exceed SCGs
5. Develop alternatives for remaining technologies
6. Analyze remedial alternatives relative to the following criteria
    - Overall protectiveness of public health and the environment
    - Conformance with SCGs
    - Long-term effectiveness and permanence
    - Reduction of toxicity, mobility, or volume with treatment
    - Short-term effectiveness
    - Implementability
    - Cost effectiveness
    - Land use
    - Community acceptance
7. Recommend a remedy for the site

5.0 SCHEDULE

This Work Plan details several task items that will be completed prior to the development of a remedial program for the site. The following tasks and the anticipated timeframe to complete each one are shown graphically on Figure 6:

- Perform Interim Remedial Measure – Implement pilot study, design SSDS and install SSDS within 120 days.

- Soil and Groundwater Sampling – Installation and sampling from borings/wells will be initiated, within 60 days of approval of this plan (weather pending).

- Complete the first phase of subsurface investigation as proposed in this Work Plan, submit an interim findings summary report within 60 days of completing field work and receipt of all laboratory analytical data.

- Remedial Investigation/Alternatives Analysis Report – To be completed within 90 days after NYSDEC completes review of the interim findings and determines that no further sampling is warranted.

6.0 FSP, QAPP, HASP, CPP, CAMP, AND IRM WORK PLAN

6.1 Field Sampling Plan

The FSP details the scope of the investigation, sampling rationale, proposed locations, analytical requirements and general methods to be used. The FSP is included as Appendix A of this document.

6.2 Quality Assurance Program Plan

Chazen's Quality Assurance Program Plan (QAPP) is included as Appendix B of this report. The QAPP is specific to all project activities conducted during remedial investigation and interim remedial measures at the site and has been developed specifically for this project.

The plan describes protocols and procedures necessary to assure that specific tasks and actions are planned and executed in a manner consistent with quality assurance objectives. These protocols and procedures will be implemented during remedial investigation and IRM activities at the site as described in the QAPP.

6.3 Health and Safety Plan

A Health and Safety Plan (HASP) for remediation investigation and interim remedial measures has been developed and will be followed to protect the health and safety of Chazen workers. The HASP developed for this site is provided in Appendix C. The HASP provides specific guidelines and establishes procedures for the protection of personnel performing currently anticipated investigation and remedial activities. The HASP includes a Contingency Plan to be implemented in the event of a threat to human health or the environment.

6.4 Citizen Participation Plan

Citizen Participation is seen as essential link between the public, Fuller Partners LLC, and the State of New York for the project. The Citizen Participation Plan (CPP), in part, describes the site, objectives, and means for the public to obtain pertinent information. The CPP is a necessary element of proposed interim remedial measures, remedial investigation activities, and remediation. The inclusion of all interested parties ensures participation in the decision making process. The CPP is included as Appendix D of this Work Plan.

6.5 Community Air Monitoring Plan

The intent of the Community Air Monitoring Plan (CAMP) is to provide a measure of protection for the downwind community (i.e. off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant release as a direct result of investigative and remedial work activities that will be performed outside.

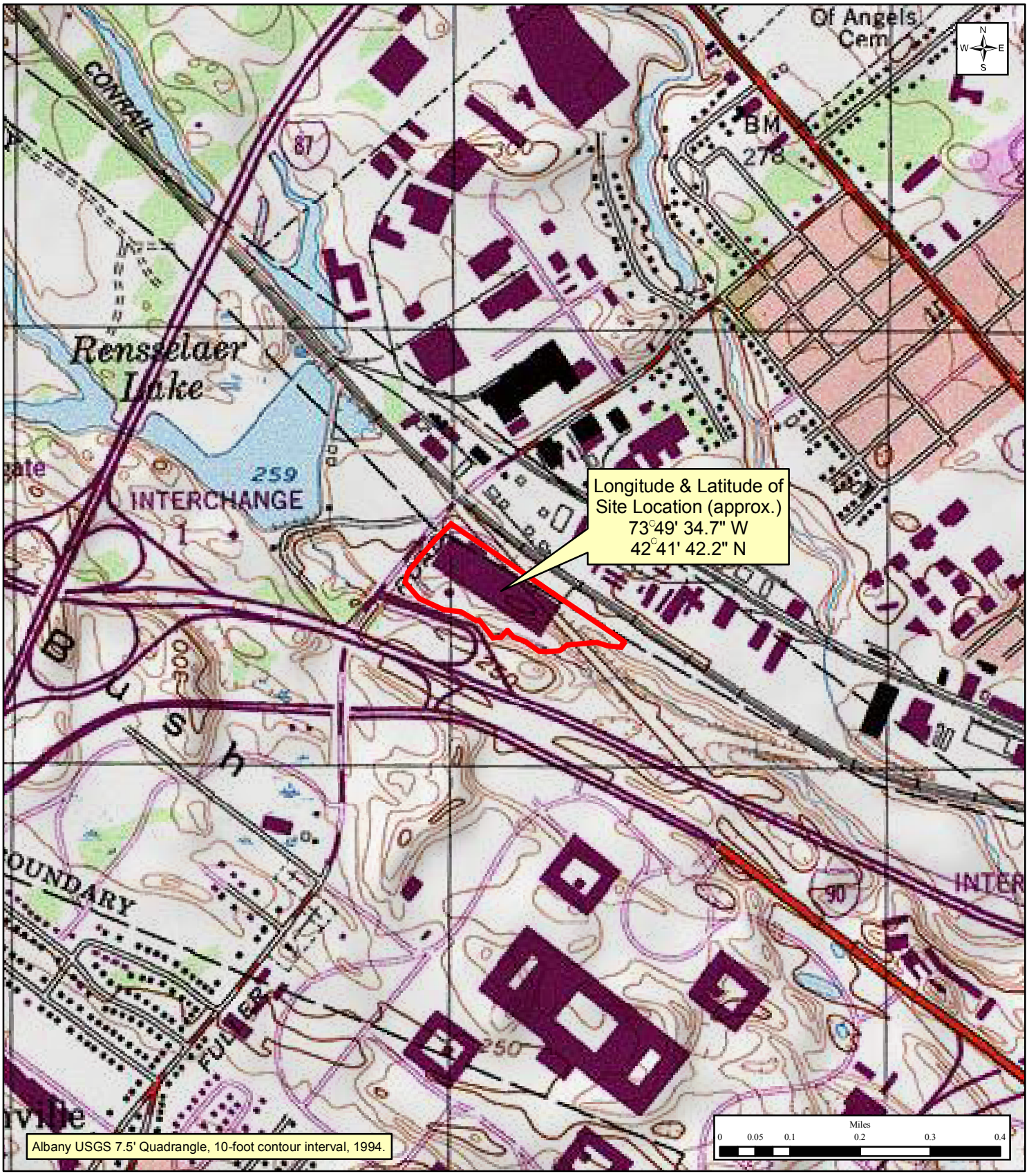
The New York State Department of Health (NYSDOH) has established an air monitoring plan for VOCs and particulate levels at the perimeter of a work area involving ground-intrusive

activities. The Community Air Monitoring Plan for Ground Intrusive Activities, established by the NYSDOH, requires that certain measures are employed on a work site when ground-intrusive activities are occurring. The CAMP is included as Appendix E of this report.

6.6 Interim Remedial Measures Work Plan

The planned site IRM is the installation of a SSDS beneath the building. The IRM Work Plan is included as Appendix F.

Figures



THE Chazen COMPANIES

ENGINEERS/SURVEYORS
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LANDSCAPE ARCHITECTS

Dutchess County Office:
21 Fox Street, Poughkeepsie, NY 12601
Phone: (845) 454-3980

Orange County Office:
356 Meadow Avenue, Newburgh, NY 12550
Phone: (845) 567-1133

Capital District Office:
547 River Street, Troy, NY 12180
Phone: (518) 273-0055

Glens Falls Office:
100 Glen Street, Glens Falls, NY 12801
Phone: (518) 812-0513

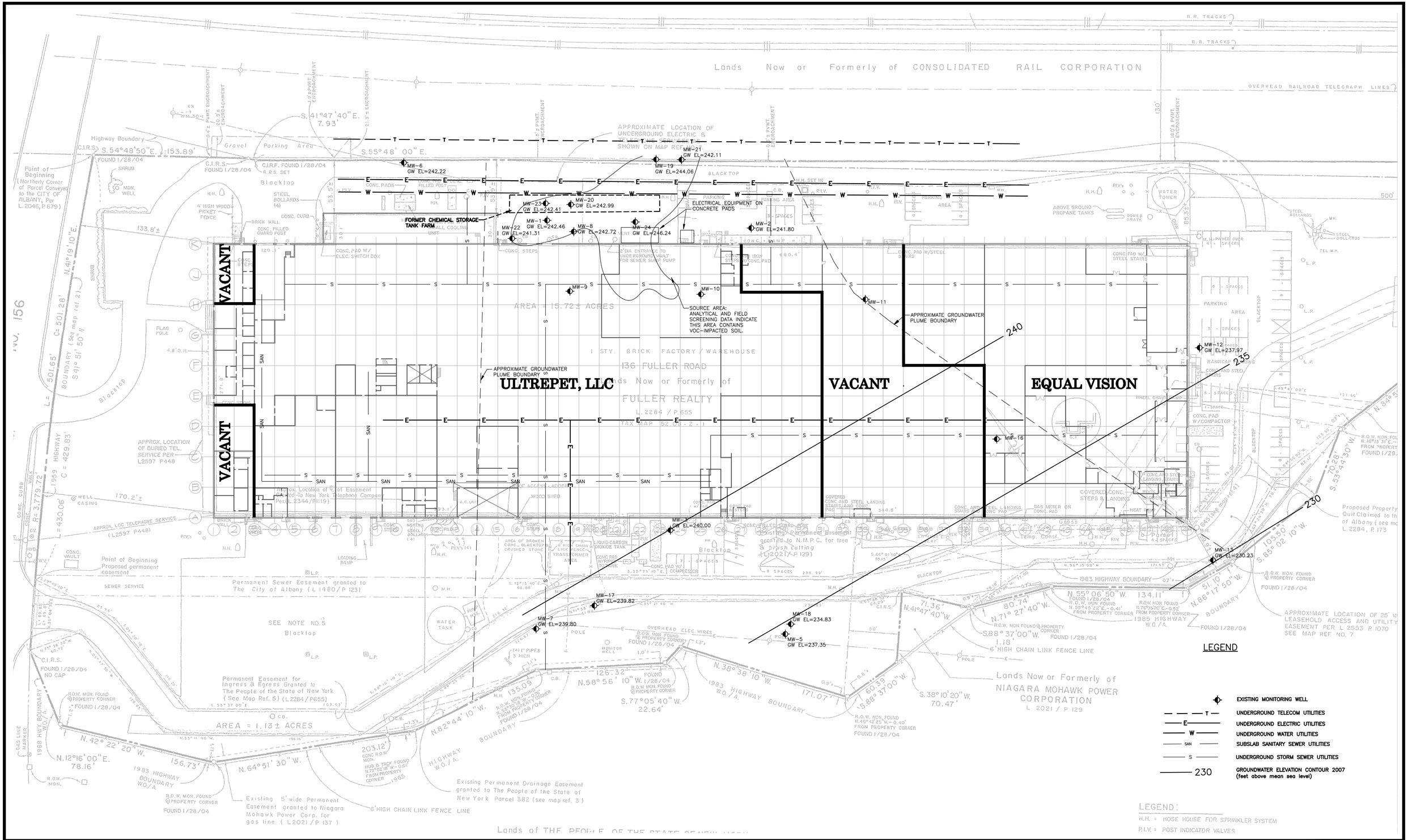
Fuller Partners, LLC

Site Location Map

136 Fuller Road
City of Albany
Albany County, New York

Drawn:	CLC
Date:	01/01/2007
Scale:	As Shown
Project:	90618.00
Figure:	1

Map Document: (R:\9\90601-90699\90618_00\GIS\maps\90618_TopographicMap_8x11.mxd)
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CHAZEN ENGINEERING, LAND SURVEYING & LANDSCAPE ARCHITECTURE CO., P.C.

Office Locations:

Dutchess County Office:
21 Fox Street
Poughkeepsie, New York 12601
Phone: (845) 454-3980

Capital District Office:
547 River Street
Troy, New York 12180
Phone: (518) 273-0055

North Country Office:
100 Glen Street
Glens Falls, New York 12801
Phone: (518) 812-0513

Connecticut:
914 Hartford Turnpike
Waterford, CT. 06385
Phone:(860) 440-2690

rev.	date	description

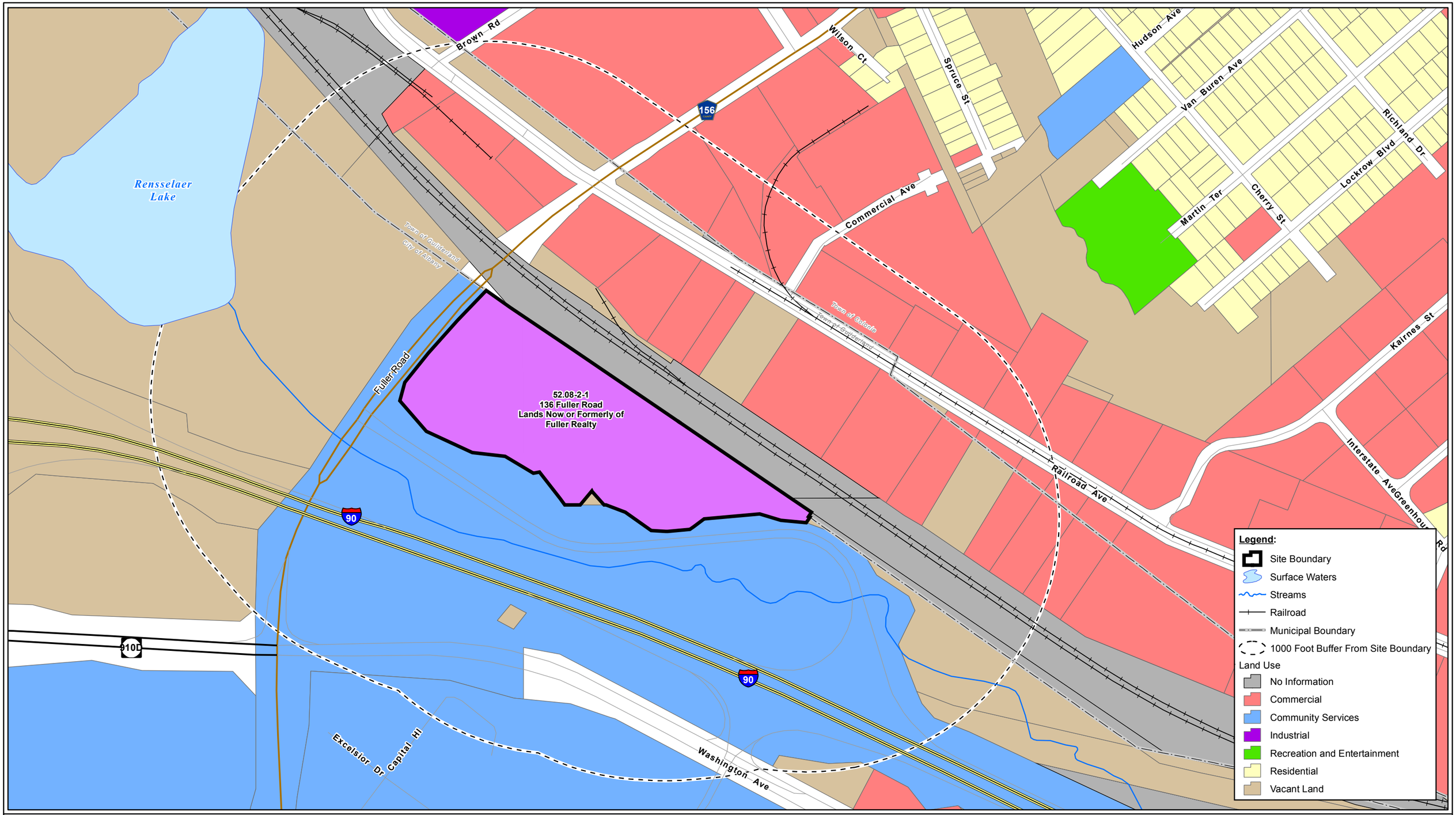
FORMER FULLER BRUSH FACILITY

SITE SURVEY WITH SOURCE AND PLUME AREAS 136 FULLER ROAD

CITY OF ALBANY, ALBANY CO., NEW YORK

drawn	checked
date	scale 1" = 40'
project no. 90618.00	
sheet no. **FIG. 2**	

Drawing Name: S:\9\90600-90699\90618_00\ENG\DWG\WP_FIG2_90618-00.DWG
Xref's Attached: XLAYOUT_90618-00; XBASE_90618-00_ARCHITECT; XIMAGE_90618-00_SURVEY; XTB_90618-00; 3TB-24X36
Date Printed: Aug 31, 2009, 3:24pm



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CHAZEN ENGINEERING, LAND SURVEYING & LANDSCAPE ARCHITECTS CO., P.C.

Dutchess County Office:
21 Fox Street
Poughkeepsie, NY. 12601
Phone: (845) 454-3980

Capital District Office:
547 River Street
Troy, NY. 12180
Phone: (518) 237-0055

North Country Office:
100 Glen Street
Glens Falls, NY. 12801
Phone: (518) 812-0513

New London:
914 Hartford Turnpike
Waterford, CT. 06385
Phone: (860) 440-2690

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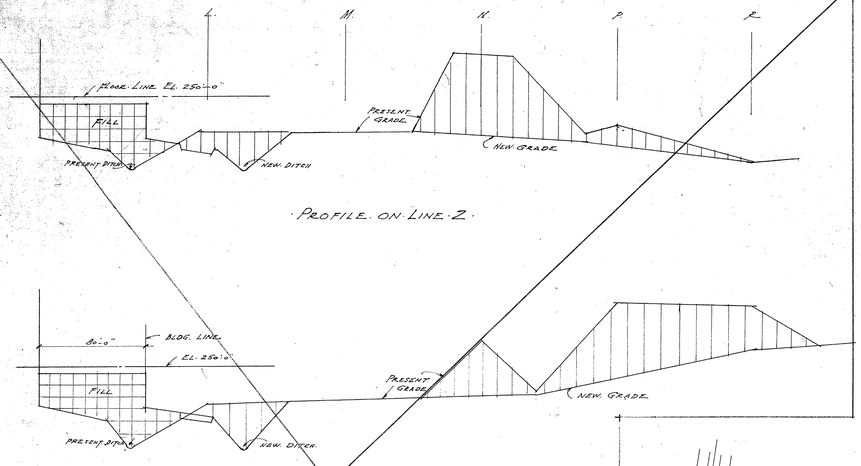
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Fuller Partners, LLC

Land Use

136 Fuller Road
City of Albany
Albany County, New York

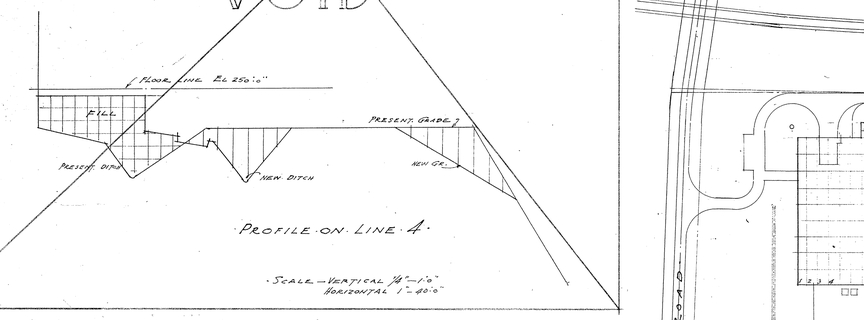
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Project:	90618.00
Figure:	3



PROFILE ON LINE 2

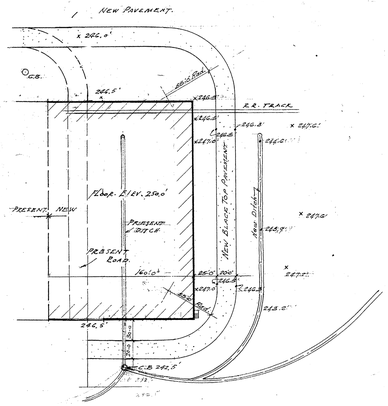
PROFILE ON LINE 3

VOID

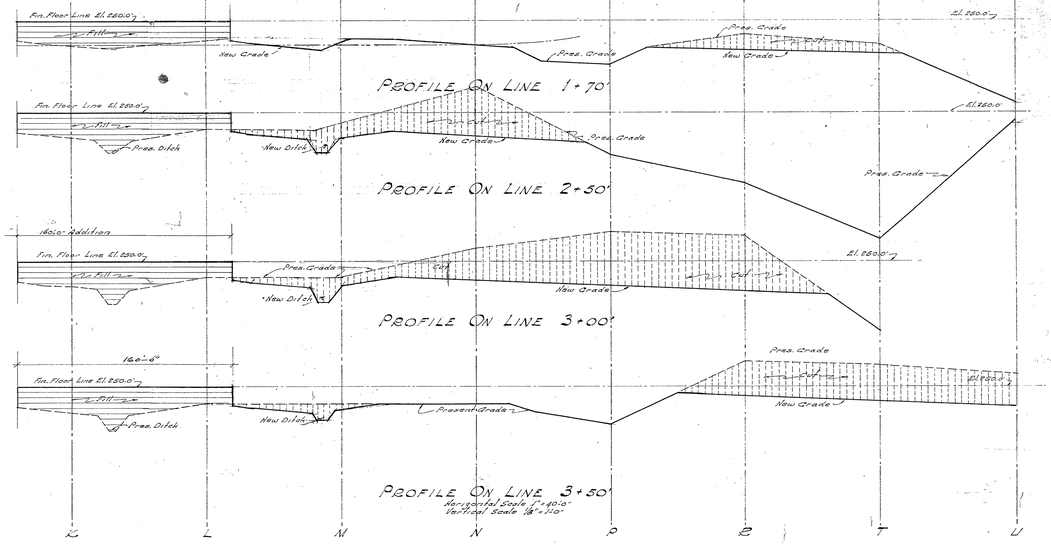


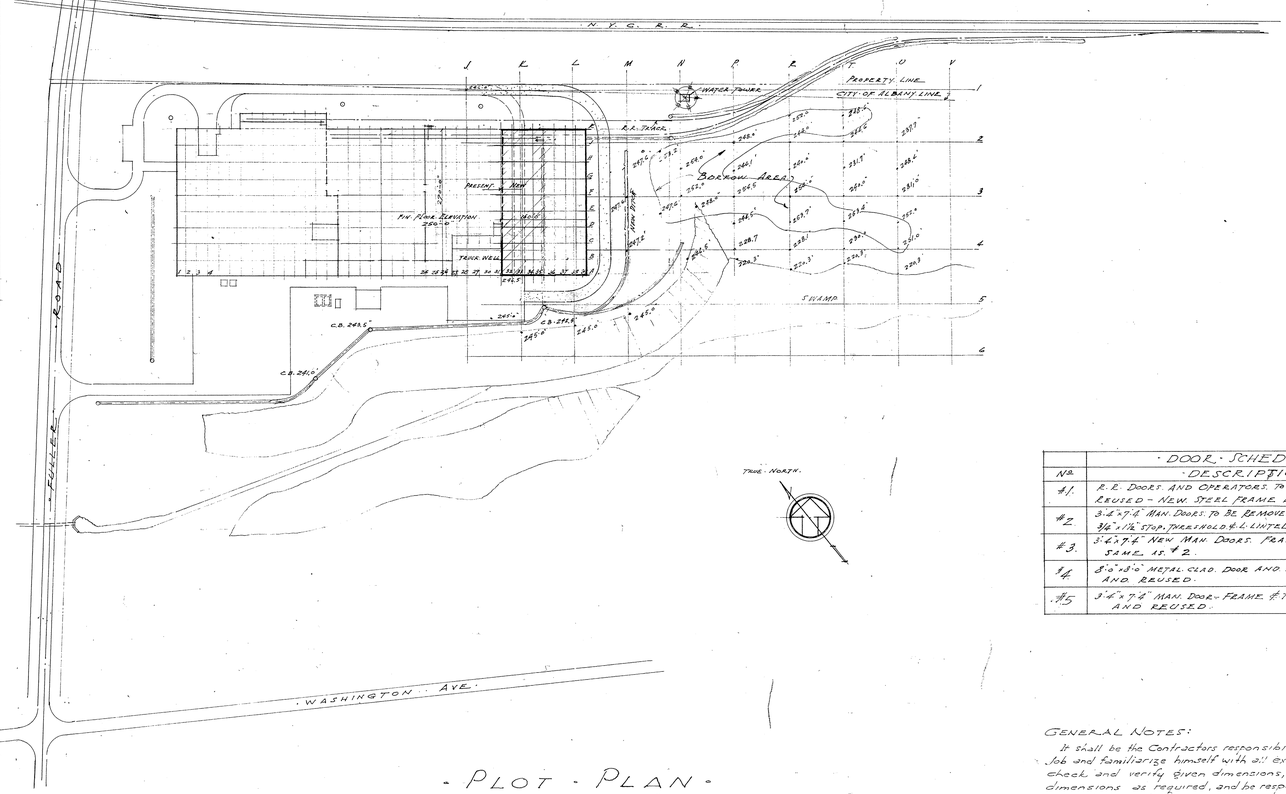
PROFILE ON LINE 4

SCALE — VERTICAL 1/4"=1'-0"
HORIZONTAL 1"=40'-0"



ENLARGED PLAN SHOWING NEW PAVEMENT DITCH AND LEVELS





PLOT PLAN

SCALE 1"=100'-0"

No.	DOOR SCHEDULE — DESCRIPTION
#1	R.E. DOORS AND OPERATORS TO BE REMOVED AND REUSED — NEW STEEL FRAME BY STRUCT. STEEL CONTR.
#2	3'-6"x7'-0" MAN DOORS TO BE REMOVED & REUSED — NEW 8" FRAME 3/8"x1½" STOP, THRESHOLD & L. LINTEL — BY MISC. IRON CONTR.
#3	3'-6"x7'-0" NEW MAN DOORS. FRAME & THRESHOLD SAME AS #2.
#4	8'-0"x8'-0" METAL CLAD DOOR AND FRAME TO BE REMOVED AND REUSED.
#5	3'-6"x7'-0" MAN DOOR — FRAME & THRESHOLD TO BE REMOVED AND REUSED.

GENERAL NOTES:
It shall be the Contractors responsibility to visit the Job and familiarize himself with all existing conditions, check and verify given dimensions, take additional dimensions as required, and be responsible for correctness of same and report any inaccuracies to the Architect-Engineer

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FIGURE 4
136 Fuller Road BCP Work Plan

KEY TO MATERIALS

BRICK · CONCRETE · BLOCK · INSULATION · PURED ROOF DECK · CRUSHED STONE · CEMENT STONE · WOOD

ADDITION TO FACTORY BUILDING
MOHAWK BRUSH COMPANY

ALBANY · NEW YORK

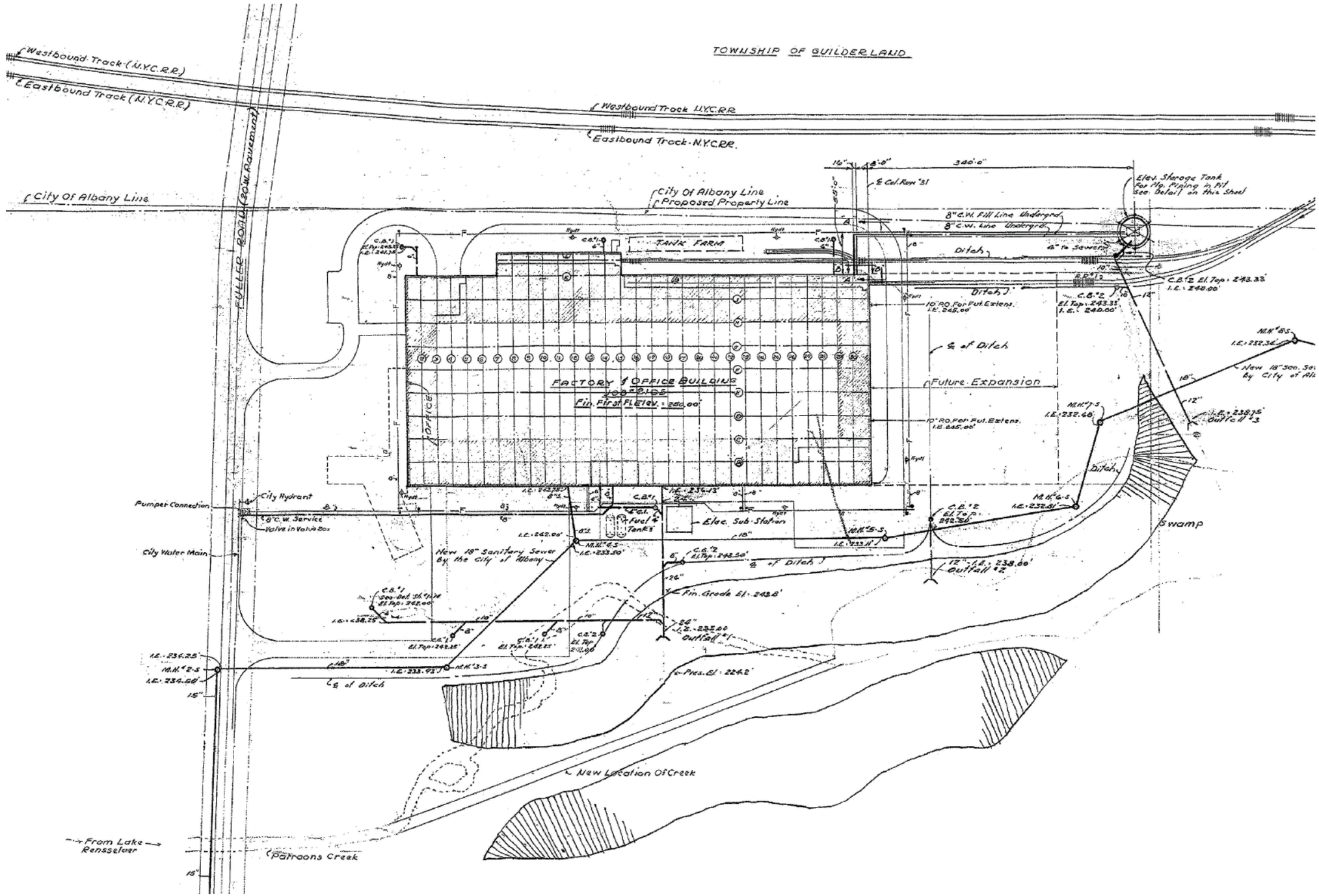
REVISIONS		
DATE	BY	BULLN. NO.
3-27-51	H.A.	#2

PLOT PLAN

GEO. H. MIEHLS
PROFESSIONAL ENGINEER
345 NEW CENTER BUILDING
DETROIT 2, MICHIGAN

ALBERT KAHN ASSOCIATED ARCHITECTS & ENGINEERS
CONSULTANTS

JOB No. 7105-B
IN CHG: ALMINE
DR: H.A.
TR: H.A.
CH: H.A.
APP:
DATE: 1-18-51
SHEET No. 1



THE Chazen COMPANIES
ENGINEERS/SURVEYORS
PLANNERS
ENVIRONMENTAL SCIENTISTS

Dutchess County Office:
21 Fox St. Poughkeepsie, NY 12601
Phone: (845) 454-3980

Capital District Office:
547 River Street, Troy, NY 12180

Glens Falls Office:
110 Glen Street Glens Falls, NY 12801

FIGURE 5-ORIGINAL PATROON CREEK LOCATION

Former Fuller Brush Manufacturing Facility
136 Fuller Road
City of Albany, Albany County, New York

Date:	2009
Scale:	As Shown
Project #:	90618.00

FIGURE 6
Estimated Schedule to Perform Work
136 Fuller Road BCP Site (NYSDEC Site No. C401055)

Scope of Work Efforts	CALENDAR																						
	2009			2010													2011						
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUN
Remedial Investigation/Remedial Alternatives Analysis Work Plan																						
30 Public Comment Period on the RI/RAA Work Plan																						
Receive NYSDEC approval of RI/AAR Work Plan						**Milestone 1**																
Interim Remedial Measures								→	→	→	→	→										
Sub-Slab Depressurization System (SSDS) Pilot Study																						
SSDS Design																						
NYSDEC/NYSDOH Reviews/Approves SSDS Design																						
Install SSDS																						
Remedial Investigation/Remedial Alternatives Analysis								→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Soil and Groundwater Sampling																						
Laboratory Sample Analysis and Data Validation																						
Prepare Draft RI/RAA																						
NYSDEC/NYSDOH review Draft RI/RAA Report																						
RI/AAR Revisions and Remedy Selection																						
NYSDEC approves RI/RAA Report																						
Mail out Fact Sheet on RI and Proposed Remedy																						
45 Public Comment Period on Proposed Remedy																						
Remedial Action Work Plan																						

Timeline for Subsequent Remedial Action Activities To Be Determined

APPENDIX A
Field Sampling Plan

Field Sampling Plan
136 Fuller Road Site
Brownfield Cleanup Program
NYSDEC Site No. C401055

City of Albany and Town of Guilderland
Albany County, New York

June 2010

THE Chazen COMPANIES®
Engineers
Environmental Professionals
Land Surveyors
Landscape Architects
Planners

Prepared for:

Fuller Partners, LLC
PO Box 370
133 Route 395
East Chatham, NY 12060

New York State Department of Environmental Conservation – Region 4
1130 N. Westcott Road
Schenectady, New York

Prepared by:

Capital District Office:
The Chazen Companies
547 River Street
Troy, New York 12180

Hudson Valley Office
(845) 454-3980

North Country Office
(518) 812-0513

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Table 1 – Analytical Methods/Quality Assurance Summary

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Figure 1 – Proposed Sample Locations

Figure 2 – Typical Well Construction Diagrams

1.0 INTRODUCTION

This Field Sampling Plan (FSP) is a component of the Remedial Investigation and Alternatives Analysis Work Plan that is prepared to supplement information collected as part of the 2007 investigation. The FSP describes the scope of field activities to be performed to acquire supplemental data to determine the type and extent of remedial action that is necessary to mitigate volatile organic compound (VOC) impacts previously identified at the site. All field work outlined below, including project documentation, will be completed in accordance with the Health and Safety Plan (HASP), Quality Assurance Program Plan (QAPP), and Community Air Monitoring Plan (CAMP) contained as appendices in the Remedial Investigation and Alternative Analysis Work Plan (Work Plan).

To meet the project objectives outlined in Section 3 of the Work Plan, the following tasks will be implemented and are described in this FSP:

- Conduct soil and groundwater sampling to fill data gaps and define the conceptual site model for the tetrachloroethylene (PCE) source area using shallow borings/wells and further delineate the clay layer with deep borings/wells (i.e., to the underlying clay layer).
- Install and sample shallow borings/wells inside the building to further define the PCE contamination plume and determine if the storm drain corridor is acting as a conduit for contaminant migration.
- Install deep borings on the south side of the building to further investigate the site geology with respect to confirming the presence of a deep (30-35 foot) clay layer.
- Sample existing groundwater monitoring wells.
- Analyze samples for VOCs or the full target compound list of contaminants, and additional physical and biological parameters to provide sufficient data to delineate contamination and evaluate proposed remedial technologies.

Sample frequency and laboratory analyses for each sample are listed in the following sections and are summarized in Table 1 at the end of this FSP. Analytical results will be compared to SCGs identified in the Work Plan document. Table 1 details the proposed sample matrixes for the FSP and Figure 1 depicts proposed sample locations.

2.0 PREPARATORY WORK

Prior to the implementation of the remedial investigation tasks, available plans will be reviewed to identify the locations of utilities on and in close proximity to the site to prevent damage during intrusive site work and to identify potential utility conduit contaminant migration pathways. Additionally, Call-Before-You-Dig will be contacted to confirm locations of utilities in the vicinity of planned borings/wells. Utilities that have previously been identified are depicted on Figure 1.

3.0 SITE SURVEY

The site has been surveyed to determine the precise boundaries of the subject property. Sample locations will be surveyed following completion of the field sampling activities. Groundwater elevations will be established for all wells based on existing survey elevation data.

4.0 SOIL INVESTIGATION

This section describes soil investigation activities. Sampling will be performed following field sampling techniques detailed in the Quality Assurance Program Plan (QAPP).

4.1 Soil Sampling Locations

Soil borings will be installed in the source area, plume area, and outside the plume area to: 1) gather data on site geology, 2) delineate contamination, and 3) gather data to support remedial decisions. The PCE source area, where substantially impacted soil was identified, is primarily beneath the eastern side of the historic tank farm and extends under the northern edge of the site building (see Figure 1). The plume area is identified where chlorinated solvent impacts exist as dissolved VOCs within a groundwater plume which extends from the source area beneath and south of the site building (see Figure 1). Additional information regarding the three rationales for sampling in the source and plume areas follows.

1) Geologic data will be gathered via collection of continuous soil samples (see Section 4.2 for details on planned drilling) from deep and shallow borings to further evaluate potential shallow pockets of clay and the deeper continuous clay layer. The presence of a deeper continuous layer will be confirmed by a 5-foot thick layer, or as otherwise agreed upon in the field with NYSDEC. The clay will be evaluated for the presence of fractures. While no borings are planned to go beneath the clay layer at this time, if field observation and analytical results indicate that contamination is present at the clay interface, deeper soil sampling for the characterization of aquifer conditions beneath the clay unit may be conducted to fully define the extent of contamination.

2) Contamination delineation will be performed by field screening soil samples and submitting samples for laboratory analysis (see Section 4.3 for details on planned screening and sampling). Samples collected from the following depths (i.e., vertical locations) will be submitted for laboratory analysis: top 2 feet of soil (selected borings where exposed surface soil is present), top of groundwater, directly above significant lithology changes, where field screening indicates the highest level of impact, and at the bottom of borings.

3) Data to support remedial decisions will be collected by submitting selected soil samples for additional analysis (see Section 4.3.3 for details on planned sampling).

Locations of soil borings are shown on Figure 1 and described as follows.

- In the source area, three deep soil borings (i.e., to the underlying clay layer; estimated maximum depth of 35 feet below ground surface [bgs]) will be installed around MW-24. These borings are identified on Figure 1 and Table 1 as MW-27, MW-28, and MW-29.
- In the source area, five shallow borings (i.e., to an estimated maximum depth of 20 feet bgs) will be installed around MW-24. These borings are identified on Figure 1 and Table 1 as B-1, B-2, MW-25, MW-26, and MW-30.
- In the plume area, two deep borings (i.e., to an estimated maximum depth of 35 feet bgs) will be installed. These borings are identified on Figure 1 and Table 1 as B-3 and B4.
- In the plume area, five shallow borings (i.e., to an estimated maximum depth of 20 feet bgs) will be installed. These borings are identified on Figure 1 and Table 1 as MW-31, MW-32, MW-33, MW-34, and MW-35.
- Outside the plume area, one shallow boring (i.e., to an estimated maximum depth of 20 feet bgs) will be installed. This boring is identified on Figure 1 and Table 1 as MW-36.

4.2 Boring Installation

Soil borings will be advanced using a direct push rig. Continuous soil samples will be collected to characterize soil and obtain samples from each sample location. Methods described in the QAPP will be followed for the installation of borings. It is expected that the driller will have multiple tooling available for use and that, initially, borings outside the building would be installed using hollow stem auger tooling and borings inside the building would be installed using the Dual Tube Soil Sampling System. Field decisions will be made as to the most appropriate tooling to use at a given location to collect continuous soil samples.

At this time, no borings are planned to go beneath the clay layer present at approximately 35 feet bgs. If sampling indicates the need for a boring to extend beyond the underlying clay layer, the boring will be grouted to prevent the potential for contaminant migration between the groundwater above and below the clay layer.

Soil cuttings generated from each boring will be placed in labeled drums and handled in accordance with the QAPP.

4.3 Soil Sampling

This section describes soil field screening, sampling methods, and analytical analysis for contamination and remediation parameters. Methods described in the QAPP will be followed for the collection of soil samples.

4.3.1 Soil Sample Field Screening

Soil samples in the source area will be field screened for 1) VOCs using a portable gas chromatograph and 2) VOCs using photoionization detector (PID). In addition, soil samples with elevated gas chromatograph, PID readings and/or visual impacts will also be screened for NAPL using an oil screening test kit that reacts to DNAPL (e.g., Oil-In-

Soil™). The QAPP describes use of the portable field gas chromatograph, which is a screening method that allows for field identification and quantification of VOCs. The QAPP also includes instructions for the PID for VOC screening and Oil-In-Soil™ instructions to screen for NAPL.

Soil samples in the plume area will also be field screened for VOCs using a portable gas chromatograph and PID. If elevated VOC readings are encountered, the soil sample will also be field screened using an oil screening test kit that reacts to NAPL (e.g., Oil-In-Soil™).

4.3.1 Soil Sampling Method

In each boring, the soil sample with elevated field screening readings will be submitted for laboratory analysis. If there is evidence of contamination at multiple depths within a boring, a second sample may also be analyzed. All soil samples will be collected following applicable methods outlined in the QAPP. Representative soils will be placed in the appropriate jars for physical and chemical testing, and detailed on Table 1. Samples that may be submitted for laboratory analysis will be placed immediately into laboratory-supplied jars. The samples will be labeled with the date and time of sampling, sample identification and site location, then packed in a cooler with ice.

Table 1 outlines sample collection frequency, sample containers for each analysis.

4.3.2 Soil Sampling Parameters for Contamination Delineation

Soil samples will be packed on ice and shipped to a New York State Environmental Laboratory Approval Program (NYS ELAP) certified laboratory for analysis. Analyses will be performed on soil to evaluate soil quality and delineate contamination. These analyses are included in Table 1.

- Soil samples from each boring will be analyzed for VOCs using EPA Method 8260.
- Soil samples from five borings (MW-26, MW-29, MW-30, B-3, and B-4) will be submitted for the full target compound list (TCL) of contaminants to obtain representative soil data within the source area. The full TCL list consists of VOCs, SVOCs via EPA Method 8270, pesticides via EPA Method 8081, PCBs EPA Method 8082, and target analyte list (TAL) metals.

4.3.3 Soil Sampling for Characterization of InSitu Remediation Parameters

Additional analyses will be performed on soil to assess remedial options. These analyses are included in Table 1. The boring/depth of these samples will be determined in the field based on location (source or plume area), soil type, and extent of contamination.

- Iron analysis (via HACH 8146 for Ferrous Iron and EPA 200.7 for Ferric Iron) will be conducted on sand and clay layers identified in the top 20 feet of saturated soil. These analyses will be conducted on two soil types in the source area and on two soil types in the plume area.

- Permeability testing will be conducted on sand and clay layers identified in the top 20 feet of saturated soil. Permeability tests will be conducted on two soil types in the source area and on two soil types in the plume area. A second boring will be installed immediately adjacent to the borehole where the sand and/or clay layers are identified and Shelby tubes will be used to collect an undisturbed sample of the target soil type.

- Treatability study will be conducted on one sample of heavily impacted soil collected from the source area and one collected from the plume area. These samples will be collected and analyzed after delineation is completed and likely treatability technologies are identified.

5.0 GROUNDWATER INVESTIGATION

This section describes sample locations and depths for the groundwater investigation, which are summarized in Table 1. Sampling will be performed following field sampling techniques detailed in the Quality Assurance Program Plan (QAPP).

5.1 Monitoring Well Locations

Monitoring wells will be installed in the source area, plume area, and outside the plume area to 1) delineate contamination and 2) gather data to support remedial decisions. Additional information regarding the rationales for sampling in the source and plume areas follows.

1) Contamination delineation will be performed by collecting groundwater samples and submitting them for laboratory analysis (see Section 5.3 for details on planned sampling). Samples will be collected from both shallow and deep wells. Groundwater from shallow wells (i.e., to an estimated maximum depth of 20 feet bgs) will represent the impacted depth identified during the 2007 investigation (generally the top 8 to 10 feet of the water table). Groundwater from deep wells (i.e., to an estimated maximum depth of 35 feet bgs) will represent water quality above the underlying clay layer.

2) Data to support remedial decisions will be collected by submitting selected groundwater samples for additional analysis (see Section 5.3.3 for details on planned sampling).

Locations of monitoring wells are shown on Figure 1 and described as follows.

- In the source area, three deep monitoring wells (i.e., to the underlying clay layer; estimated maximum depth of 35 feet bgs) will be installed around MW-24. These wells are identified on Figure 1 and Table 1 as MW-27, MW-28, and MW-29.
- In the source area, three shallow monitoring wells (i.e., to an estimated maximum depth of 20 feet bgs) will be installed around MW-24. These wells are identified on Figure 1 and Table 1 as MW-25, MW-26, and MW-30.
- In the plume area, five shallow monitoring wells (i.e., to an estimated maximum depth of 20 feet bgs) will be installed. These borings are identified on Figure 1 and Table 1 as MW-31, MW-32, MW-33, MW-34, and MW-35.
- Outside the plume area, one shallow monitoring well (i.e., to an estimated maximum depth of 20 feet bgs) will be installed. This well is identified on Figure 1 and Table 1 as MW-36.
- Nine existing groundwater monitoring wells located in the source area (MW-1, MW-2, MW-8, MW-19, MW-20, MW-21, MW-22, MW-23, MW-24) will be included in this investigation.
- Nine existing groundwater monitoring wells located in the plume area (MW-3, MW-5, MW-7, MW-9, MW-10, MW-11, MW-16, MW-17, MW-18) will be included in this investigation.
- An existing up gradient monitoring well (MW-6) and down gradient well (MW-13) will be included in this investigation.
- Should field screening of soil indicate the presence of NAPL in a boring that is not listed as being completed as a well, then a well will be installed at this boring location and included in the groundwater investigation.

5.2 Monitoring Well Installation

Well construction methods and materials are specified in the QAPP, and typical well diagrams for deep and shallow wells are provided in Figure 2. Monitoring wells will be installed within the soil borings and will consist of 1- or 2-inch diameter Schedule 40 polyvinyl chloride (PVC) with 0.02-inch (20-slot) screen slot size.[1] Deep monitoring wells will be constructed with 5 feet of screen at the bottom of the boring, while shallow monitoring wells will be constructed with 10 feet of screen placed within the top 10 feet of saturation. Well screen that is pre-packed with sand may be used. A 2-foot thick layer of bentonite will be installed above the top of the screen. Sand or native material will be used to backfill the annular space above the bentonite. The top 2 feet of the borehole will be filled with a bentonite or concrete seal. A locking well cap will be installed in the top of the casing. A protective casing will be installed in concrete at the ground surface to prevent damage, provide security, and to provide a seal to prevent surface runoff from

[1] Note: Should a well be intended for permeability testing, a 2-inch diameter well would be installed in a boring drilled with a hollow stem auger. In this instance, the top of screen would be placed beneath the top of the groundwater surface.

entering the well. The protective casing may be flush mounted or stick up above the ground depending on the location.

Following installation and prior to sampling, the wells will be developed in accordance with the specifications outlined in the QAPP by purging approximately 10 well volumes of water until temperature, pH, turbidity, and specific conductivity are stabilized. Development and purge water generated from each well will be placed in labeled drums and handled in accordance with the QAPP.

5.3 Groundwater Sampling

Prior to sampling, each groundwater monitoring well will be accessed and gauged to determine the depth to groundwater. Gauging will be conducted at all wells prior to initiating any groundwater sampling or field-testing procedure. In so doing the gauging data will represent static conditions at a specific "moment in time." All gauging data will be recorded in the sampler's field book as outlined in the QAPP.

Following the gauging data collection, the wells will be purged to allow collection of representative groundwater samples. The purge method will be a low flow procedure designed to limit the drawdown inside the well. This low flow method minimizes the stress on the groundwater system by setting the intake velocity of the sampling pump to a flow rate that limits drawdown. Each monitoring well will be purged until temperature, pH, turbidity, oxidation reduction potential (ORP), and specific conductivity are stabilized as defined in the QAPP.

5.3.1 Groundwater Sampling Method

All groundwater samples will be collected following applicable methods outlined in the QAPP. Groundwater samples will immediately be placed into appropriate laboratory-supplied bottles for physical and chemical testing. The samples will be labeled with the date and time of sampling, sample identification and site location, then packed for shipment to the laboratory in a cooler with ice.

Table 1 outlines sample collection frequency, sample containers for each analysis.

5.3.2 Groundwater Sampling Parameters for Contamination Delineation

Groundwater samples will be packed on ice and shipped to a NYS ELAP certified laboratory for analysis. Analyses will be performed on groundwater to evaluate groundwater quality and delineate contamination. These analyses are included in Table 1.

- Groundwater samples from each well will be analyzed for VOCs using EPA Method 8260.
- Groundwater samples from three source area wells (MW-26, MW-29, and MW-30), two plume area wells (MW-5 and MW-18), and one well outside the plume area (MW-36) will be submitted for the full target compound list (TCL) of

contaminants to obtain representative groundwater data within the source area. The full TCL list consists of VOCs, SVOCs via EPA Method 8270, pesticides via EPA Method 8081, PCBs EPA Methods8082, and TAL metals.

5.3.3 Groundwater Sampling for Characterization of InSitu Remediation Parameters

As data collected to-date show that contamination is located in the upper ten feet of the saturated zone, additional analyses will be performed on shallow groundwater to assess remedial options. These analyses are included in Table 1. Data are needed for the source area, plume area, and up gradient and down gradient of the impacted areas.

Data needed for the source area consist of the following:

- Iron(via HACH 8146 for Ferrous Iron and EPA 200.7 for Ferric Iron), Manganese (EPA Method 200.7), Chloride (SM4500 Cl C,E), Sulfate/Sulfide(Sulfate by EPA 300.0, sulfide by EPA 9030/9034), Nitrate (Ion Chromatography [IC] Method E300), Alkalinity (SM2320B), and total organic carbon (Method 415.1)analyses will be conducted on three source area wells (MW-24, MW-25 and MW-30), two plume area wells (MW-32 and MW-33), up gradient well MW-6 and down gradient well MW-13.

- Analyses for methane, ethane and ethane and degrading bacteria (e.g., *Dehalococcoides*) will be conducted on two source area wells and two plume area wells with the highest contaminant concentrations. Samples for ethane degraders will either be collected in poly bottles or byusing Bio-Trap® samplers. Bio-Trap® samplers would be installed in wells following the groundwater sampling event and microbes will be allowed to grow for 30 to 60 days.

6.0 SUB-SLAB SOIL VAPOR INVESTIGATION

This section describes the sub-slab soil vapor investigation. Sampling will be performed following field sampling techniques detailed in the NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006).

Locations of sub-slab vapor points will be determined after the SSDS is designed and installed. Vapor samples will be analyzed for VOCs via EPA Method TO-15.

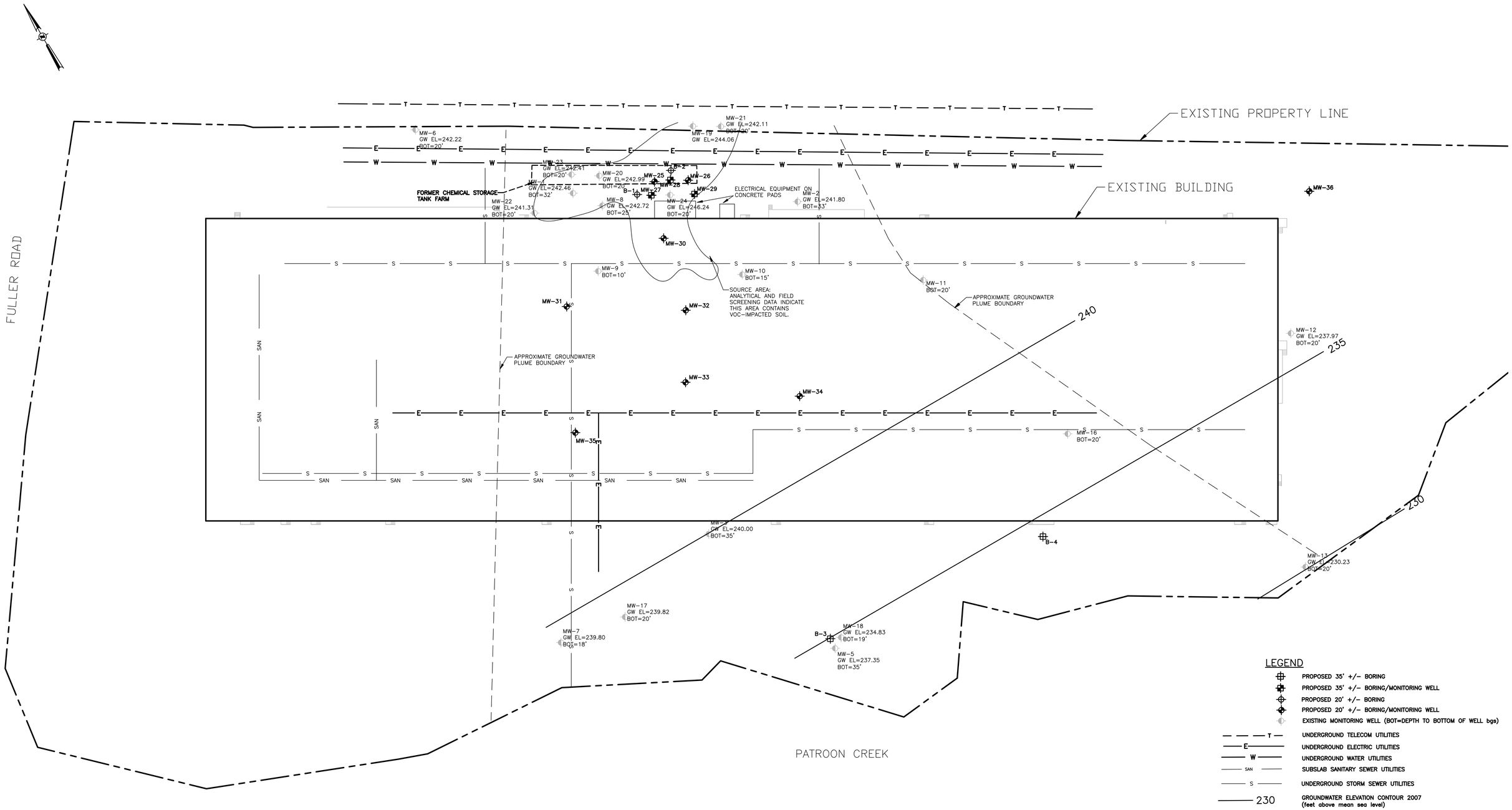
Table 1
Analytical Methods/Quality Assurance Summary Table
136 Fuller Road BCP Site

Sample Area and Description	Sample Depths and Rationale	TCL VOCs (8260)[1]	Full TCL[2]	Treatability Study[3]	Permeability (Shelby Tubes)[4]	Iron, Manganese, Chloride, Sulfate/Sulfide, Nitrate, Alkalinity[5]	TOC[6] (415.1)	Methane, Ethane, Ethene[7]	Degrading bacteria[8]
Source Area									
Three deep borings/wells (MW-27, MW-28, MW-29)	Soil Sampling Depths (up to 4 per boring): • 0-2' (MW-29 only) • Top of groundwater • Directly above significant lithology changes • Where field screening indicates highest level of impact • Bottom of boring (~35' bgs) Groundwater Sampling Depths: • 25-35' bgs Sampling Rationale: Gather geologic data and delineate contamination.	Up to 8 soil (MW-27, MW-28) 2 water (MW-27, MW-28)	Up to 5 soil (MW-29) 1 water (MW-29)						
Five shallow borings (B-1, B-2, MW-25, MW-26, MW-30) **Three shallow wells** (MW-25, MW-26, MW-30)	Soil Sampling Depths (up to 4 per boring): • 0-2' (MW-26 only) • Top of groundwater • Above significant lithology changes • Where field screening indicates highest level of impact • Bottom of boring (~20' bgs) Groundwater Sampling Depths: • 10-20' bgs Sampling Rationale: Gather geologic data, delineate contamination above 20' bgs, and gather data to support remedial decisions.	Up to 12 soil (B-1, B-2, MW-25) 1 water (MW-25)	Up to 9 soil (MW-26, MW-30) 2 water (MW-26, MW-30)	1 soil[9]	1 soil (sand) 1 soil (clay)	1 soil (sand) for total iron 1 soil (clay) for total iron 2 water (MW-25, MW-30)	2 water (MW-25, MW-30)	2 water (MW-25, MW-30)	2 water[10]
Existing wells (MW-1, MW-2, MW-8, MW-19, MW-20, MW-21, MW-22, MW-23, MW-24)	Groundwater Sampling Depths: • 10-20' bgs or 25'-35' bgs Groundwater Sampling Rationale: Delineate contamination and gather data to support remedial decisions.	9 water				1 water (MW-25)	1 water (MW-25)		
Existing up gradient well MW-6 **down gradient well** MW-13	Sampling Depths (up to 4 per boring): • 10-20' bgs Groundwater Sampling Rationale: Gather data to support remedial decisions.	2 water				2 water	2 water		
Plume Area									
Five shallow borings/wells in building (MW-31, MW-32, MW-33, MW-34, MW-35)	Soil Sampling Depths (up to 4 per boring): • Top of groundwater • Above significant lithology changes • Where field screening indicates highest level of impact • Bottom of boring (~20' bgs) Sampling Rationale: Gather geologic data, delineate contamination above 20' bgs, and gather data to support remedial decisions.	Up to 20 soil 5 water		1 soil[9]	1 soil (sand) 1 soil (clay)	1 soil (sand) for total iron 1 soil (clay) for total iron 2 water (MW-32, MW-33)	2 water (MW-32, MW-33)	2 water (MW-32, MW-33)	2 water[10]
Two deep borings south of building (B-3, B-4)	Soil Sampling Depths (up to 5 per boring): • 0-2' • Top of groundwater • Above significant lithology changes • Where field screening indicates highest level of impact • Bottom of boring (~35' bgs) Sampling Rationale: Gather geologic data, delineate contamination above 35' bgs, and gather data to support remedial decisions.	Up to 5 soil (B-4)	Up to 5 soil (B-3)						

Table 1
Analytical Methods/Quality Assurance Summary Table
136 Fuller Road BCP Site

Sample Area and Description	Sample Depths and Rationale	TCL VOCs (8260)[1]	Full TCL[2]	Treatability Study[6]	Permeability (Shelby Tubes)[4]	Iron, Manganese, Chloride, Sulfate/Sulfide, Nitrate, Alkalinity[5]	TOC[6] (415.1)	Methane, Ethane, Ethene	Degrading bacteria[7]
Existing wells (MW-3, MW-5, MW-7, MW-9, MW-10, MW-11, MW-16, MW-17, MW-18)	Groundwater Sampling Depths: • 10-20' bgs or 25'-35' bgs Groundwater Sampling Rationale: Delineate contamination and gather data to support remedial decisions.	7 water (MW-3, MW-7, MW-9, MW-10, MW-11, MW-16, MW-17)	2 water (MW-5, MW-18)						
Outside Plume Area									
One shallow boring/well in northeast of building (MW-36)	Soil Sampling Depths (up to 4 per boring): • Top of groundwater • Above significant lithology changes • Where field screening indicates highest level of impact • Bottom of boring (~20' bgs) Sampling Rationale: Gather geologic data, delineate contamination above 20' bgs, and gather data to support remedial decisions. Groundwater Sampling Depths: • 10-20' bgs Groundwater Sampling Rationale: Delineate contamination.		Up to 4 soil (B-4) 1 water (MW-36)						
Range of Primary Sample Quantities		*Up to 45 soil 26 water*	*Up to 23 soil 6 water*		*4 soil*	*4 soil 7 water*	*7 water*	*4 water*	*4 water*
Quality Assurance Samples[11]									
Field Duplicates		2 soil 1 water	1 soil 1 water						
Trip Blanks		Up to 3							
Equipment Blanks		2	1						
Matrix Spike/Matrix Spike Duplicate		3 soil 2 water	2 soil 2 water						
Range of Sample Quantities (including QC)		Up to 84	36		4	11	7	4	4

1. TCL = target compound list; VOCs = volatile organic compounds. Soil sample: one 4-oz jar. Groundwater sample: three 40-mL VOAs with HCL preservative and no head space.
2. Full TCL = VOCs via EPA Method 8260, SVOCs via EPA Method 8270, pesticides via EPA Method 8081, PCBs via EPA Methods 8082, and target analyte list (TAL) metals. Soil sample: one 8-oz jar and one-4-oz jar. Groundwater sample: three 40-mL VOAs with HCL, three 1-L amber bottles, two 250-mL poly bottles with HNO_3.
3. Treatability Study will evaluate how the contamination responds to various remedial technologies. Multiple studies will be conducted to evaluate several remedial technologies.These samples will be collected after delineation is completed.
4. Shelby tubes will be collected from a boring immediately adjacent to a borehole where sand and clay layers are identified in the top 20 feet of saturated soil.
5. Iron (HACH 8146 Ferrous Iron and EPA 200.7 for Ferric Iron): Soil sample: one 8-oz jar. Iron, Manganese (EPA Method 200.7), Chloride (SM4500 Cl C,E), Sulfate/Sulfide(Sulfate by EPA 300.0, sulfide by EPA 9030/9034), Nitrate (Ion Chromatography [IC] Method E300), Alkalinity (SM2320B). Soil sample: one 8-oz jar. Groundwater sample: one 250-mL poly bottle with HNO_3, one 500-mL poly bottle unpreserved, and one 500-mL poly bottle with NaOH and $C_4H_6O_4ZN$
6. TOC = total organic carbon. Groundwater sample: one 250-mL poly bottle with H_2SO_4 preservative.
7. Methane, ethane, ethane groundwater samples: two 40-mL VOAs unpreserved and no head-space.
8. Microbial analysis for degrading bacteria (e.g., *Dehalococcoides*) via Bio-Dechlor CENSUS analysis. Groundwater sample: either Bio-Trap samplers or two 500-mL unpreserved poly bottles.
9. Samples will be collected from one heavily contaminated soil sample in the source area and one contaminated soil sample from the plume area.
10. Degrading bacteria samples will be collected from wells with the highest contaminant concentrations.
11. Quality assurance field samples will be collected at the following frequencies:
    Field Duplicates – 1 for every 20 samples collected per media.
    Trip Blanks – 1 trip blank for each shipment of water samples for VOC analysis.
    Equipment Blanks – 1 equipment blank per day of sampling, up to 3 maximum.
    MS/MSD – 1 per matrix (2), 1 per 20 samples and 1 per every seven days of sampling (up to 2)



LEGEND

- PROPOSED 35' +/- BORING
- PROPOSED 35' +/- BORING/MONITORING WELL
- PROPOSED 20' +/- BORING
- PROPOSED 20' +/- BORING/MONITORING WELL
- EXISTING MONITORING WELL (BOT=DEPTH TO BOTTOM OF WELL bgs)
- UNDERGROUND TELECOM UTILITIES
- UNDERGROUND ELECTRIC UTILITIES
- UNDERGROUND WATER UTILITIES
- SUBSLAB SANITARY SEWER UTILITIES
- UNDERGROUND STORM SEWER UTILITIES
- GROUNDWATER ELEVATION CONTOUR 2007 (feet above mean sea level)

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ORIGINAL SCALE IN INCHES

THE Chazen COMPANIES®
Engineers/Surveyors
Planners
Environmental Scientists
Landscape Architects

CHAZEN ENGINEERING, LAND SURVEYING & LANDSCAPE ARCHITECTURE CO., P.C.

Office Locations:

Dutchess County Office:
21 Fox Street
Poughkeepsie, New York 12601
Phone: (845) 454-3980

Capital District Office:
547 River Street
Troy, New York 12180
Phone: (518) 273-0055

North Country Office:
100 Glen Street
Glens Falls, New York 12801
Phone: (518) 812-0513

Connecticut:
914 Hartford Turnpike
Waterford, CT. 06385
Phone:(860) 440-2690

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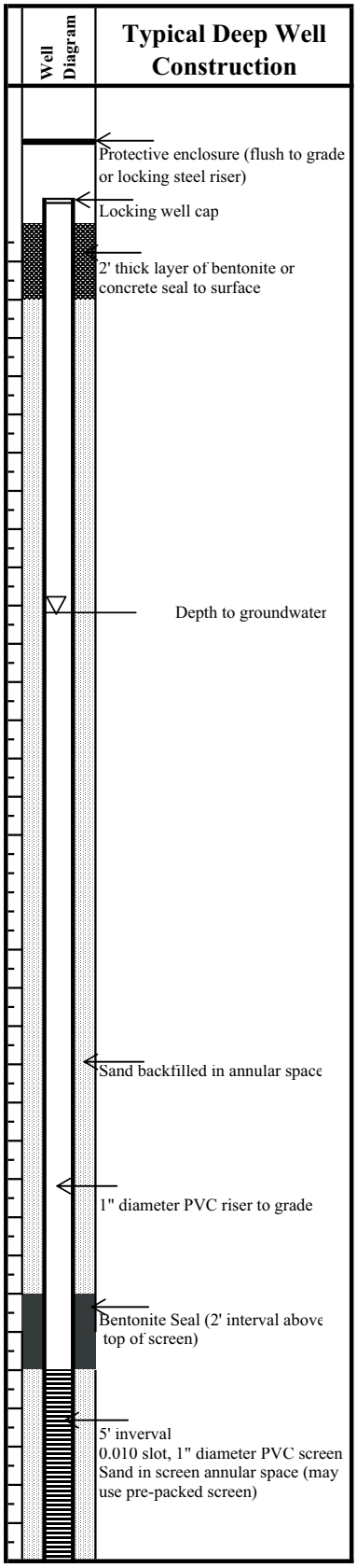
FORMER FULLER BRUSH FACILITY

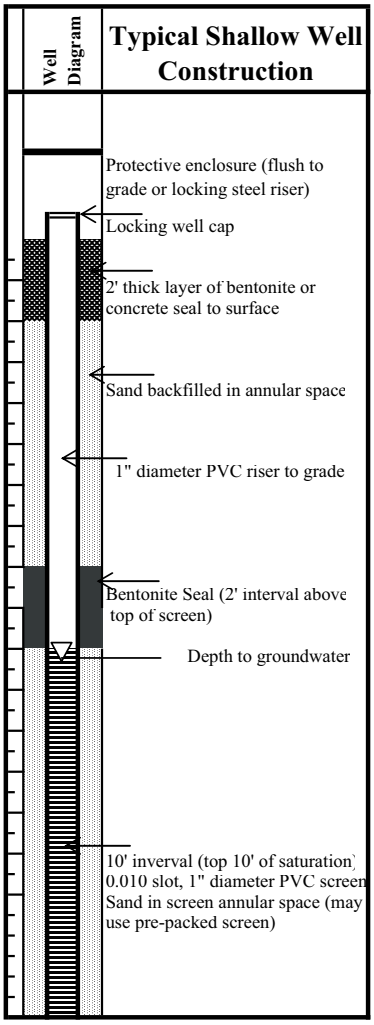
PROPOSED BORING AND MONITORING WELL LOCATIONS 136 FULLER ROAD

CITY OF ALBANY, ALBANY CO., NEW YORK

drawn	checked
date	scale 1" = 40'
project no. 90618.00	
sheet no. **FIG. 1**	

Drawing Name: S:\9\90600-90699\90618_00\ENG\DWG\FIG1_90618-00.DWG
Xref's Attached: XLAYOUT_90618-00; XBASE_90618-00_ARCHITECT; XIMAGE_90618-00_SURVEY; XTB_90618-00; 3TB-24X36
Date Printed: Mar 26, 2010, 3:51pm





Note: 2" diameter wells may be installed in hollow stem auger borings.

THE Chazen COMPANIES®
ENGINEERS/SURVEYORS
PLANNERS
ENVIRONMENTAL SCIENTISTS
LANDSCAPE ARCHITECTS

Dutchess County Office:
21 Fox St. Poughkeepsie, NY 12601
Phone: (845) 454-3980

Capital District Office:
547 River Street, Troy, NY 12180
Phone: (518) 273-0055

Glens Falls Office:
100 Glen Street, Glens Falls, NY 12801
Phone: (845) 812-0513

Connecticut:
914 Hartford Turnpike, Waterford, CT 06385
Phone: (860) 440-2690

Fuller Partners, LLC
FIGURE 2
Typical Well Construction Diagrams
136 Fuller Road
City of Albany, Albany County, New York

Date: 3/30/2010
Scale: Not to Scale
Project #: 90618.00

APPENDIX B
Quality Assurance Project Plan

Quality Assurance Program Plan
136 Fuller Road Site
Brownfield Cleanup Program
NYSDEC Site No. C401055

City of Albany and Town of Guilderland
Albany County, New York

June 2010

THE Chazen COMPANIES®
Engineers
Environmental Professionals
Land Surveyors
Landscape Architects
Planners

Prepared for:

Fuller Partners, LLC
PO Box 370
133 Route 395
East Chatham, NY 12060

New York State Department of Environmental Conservation – Region 4
1130 N. Westcott Road
Schenectady, New York

Prepared by:

Capital District Office:
The Chazen Companies
547 River Street
Troy, New York 12180

Hudson Valley Office
(845) 454-3980

North Country Office
(518) 812-0513

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Attachments

Oil-In-Soil™ Instruction Manual and Material Safety Data Sheet

Geoprobe® Standard Operating Procedures for the

Dual Tube Soil Sampling System and

Macro-Core® Soil Sampling System

1.0 PROGRAM DESCRIPTION

This Quality Assurance Program Plan (QAPP) describes protocols and procedures necessary to ensure that specific tasks and actions undertaken by The Chazen Companies (TCC) are planned and executed in a manner consistent with the Quality Assurance (QA) objectives. This QAPP also details responsibilities for compliance with these requirements.

The QAPP provides guidance and specifications for:

- Organizational structure within The Chazen Companies
- A method for determining Data Quality Objectives
- All routine calibration and sampling procedures conducted by The Chazen Companies
- Chain of Custody requirements and Analytical Procedures
- Data Reduction, Validation, and Reporting
- Internal Quality Control and Internal Auditing
- Specific Routines to Assess Data Quality
- Preventative Maintenance
- Performance Reporting

This document will support all work performed by TCC in the areas of soil and groundwater Remedial Investigations and Alternatives Analyses, environmental site audits, Remedial Design (RD) and long-term environmental monitoring.

The format for this QAPP is based on "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final", 1988 (EPA/540/G-89/004), "Data Quality Objectives for Remedial Response Activities (Development Process)", 1987 (EPA/540/G-87/003), and on NYSDEC Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation (DER-10, Draft November 2009) .

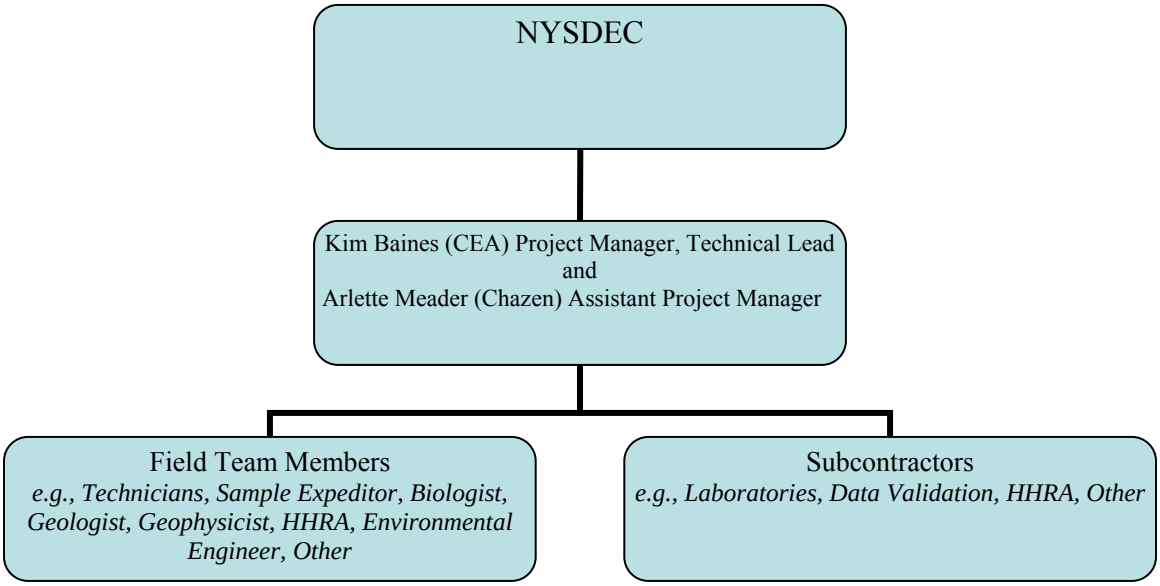
The QAPP is divided into 14 sections as described in the document "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final", 1988 (EPA/540/G-89/004).

2.0 PROGRAM ORGANIZATION

2.1 Company Organization

The Chazen Companies assigns a specialized team of experts to each project. These individuals act together to meet the needs of the project. Each project is assigned a Project Principal and Project Manager who oversee the components of the project. The project organization chart is shown below.

Organization Plan



2.2 Specific Responsibilities

Principals: Principals of The Chazen Companies are responsible for establishing a contract for the services to be performed, for committing the corporate resources necessary to conduct the program work activities, and for supplying corporate-level input for problem resolution.

Project Manager: The Project Manager will be responsible for establishing protocols to be used during the investigation and remedial activities, and establishing sampling methods. He will provide oversight and technical guidance during field activities and report preparation, maintain quality and consistency, and monitor the overall work progression. The Project Manager is responsible for the management and quality of the project. The Project Manager is named in the Site Investigation Work Plan and may be the Director of Environmental Services or his/her designee (e.g. Assistant Project Manager). The Project Manager is responsible for ensuring that

all project objectives are met, including schedule and budget tracking, QA adherence, and ultimate product delivery. The duties and responsibilities of the Project Manager include:

- General supervision of project execution to ensure that the project objectives are met on schedule and on budget.
- Assisting in project activities.
- Financial management.
- Identifying project staff, equipment, and other resource requirements.
- Conducting project progress meetings with the client and the technical reviewers.
- Final review of project deliverables prior to issue.
- Implementation of subcontracting, as required.

Field Operations Leader: The Field Operations Leader named in the Work Plan is usually a member of the Senior Environmental staff at The Chazen Companies and is responsible for the coordination and execution of the field activities, data reduction, and interpretation. Assigned responsibilities include:

- Organization of personnel, equipment, and materials to meet the objectives of the field tasks.
- Direction of field activities in accordance with the Work Plan and project QAPP.
- Coordination of subcontractor activities including verification and adequacy of subcontractor QA/QC programs.
- Assisting in project activities.
- On-going Quality Control (QC) during performance of work.
- Field and laboratory data reduction and interpretation.
- Execution of corrective actions for identified QA/QC problems.
- Supervision of field team.
- Supervision of deliverable preparation.

Technical Reviewer/Quality Assurance Manager: The Technical Reviewer(s) named in the Work Plan is (are) generally peer reviewers, the Director of The Chazen Companies or the managing Principal. Technical reviewers review field data and methodology and act as Quality Assurance Managers. The Technical Reviewer(s) will be responsible for the overview of tasks and procedures, which affect the quality of work performed during the investigation. The Technical Reviewer/Quality Assurance Manager is responsible for:

- Verification of the Quality Assurance Program through evaluation and overview of program tasks.
- Identification of problems affecting quality and recommending corrective actions.
- Reporting to the Project Manager on the status and adequacy of the overall QA program.
- Consultation on data analysis and interpretation.
- Technical review of the project.

Field Team Member: Field Team Members involved in the field investigation, geophysical survey, location and elevation survey, or other field activities are responsible for the on-site

execution of planned field activities. Field team members named in the Work Plan are assigned responsibilities which may include:

- Completion of all field activities in accordance with the Work Plan.
- Field supervision of subcontractor activities.
- Monitoring of, and adherence to, health and safety requirements in accordance with the HASP during field activities.

2.3 Personnel Qualifications and Training

The Project Manager and the Quality Assurance Manager review the assignment of technical staff and the project management plan with regard to the appropriate qualifications in the technical areas relevant to the Project and any associated QC techniques. Training, if required, is specified and implemented prior to project start-up.

Site-specific training is provided to all members of the field team and includes:

- General briefings covering the QA program and Project plans;
- Detailed briefings on specific methods required by the Work Plan and QAPP;
- Specific briefings on individual QA and QC procedures and activities.

All employees of TCC involved with hazardous waste investigations are required to attend an OSHA-approved 40-hour health and safety course prior to working on hazardous waste sites. In addition, these employees are required to annually attend an 8-hour refresher health and safety course and to participate in a medical surveillance program.

2.4 Analytical Laboratory and Other Support Services

The subcontractors for analytical services will be determined prior to the initiation of the field investigations. Data validation, if required, will be performed by The Chazen Companies or by a qualified firm.

The responsibility for implementing the laboratory QA Program resides with the laboratory subcontractor's Laboratory Analytical Task Manager. The Laboratory Analytical Task Manager is responsible for the following:

- Following the Project QC Plan.
- Supporting the TCC Project Manager and Quality Assurance Manager.
- Maintaining sufficient instruments, space resources, and personnel to perform the analyses as necessary.
- Handling/receiving samples in a manner consistent with New York State and Federal guidance as outlined in the Work Plan/QAPP.
- Implementing corrective action to account for analytical problems or QC deficiencies.
- Maintaining appropriate instrument controls/calibration.
- Reviewing all sampling and analyses, instrument blanks, sample blanks, and other QA/QC information to ensure that it meets the desired quality standards.

- Providing QA/QC checks at the proper frequency and maintaining an awareness of the laboratory condition to detect conditions which might jeopardize controls of the various analytical systems (e.g. improper calibration, improper sample storage conditions, and equipment maintenance intervals).
- Providing in-house QC audit documentation for sample storage, labeling, preservation, transportation, and disposal in accordance with Analytical Services Protocol (ASP).

3.0 QUALITY ASSURANCE OBJECTIVES

Quality Assurance (QA) is a management system that ensures that all information, data, and decisions generated during a site investigation or feasibility study is technically sound and properly documented. Quality Control (QC) is the functional mechanism through which the quality assurance objectives are achieved. The overall objective of the QA/QC program is to establish procedures such that data obtained from the field and laboratory analyses are of adequate quality to satisfy the project objectives.

3.1 Data Quality Objectives

Data quality objectives (DQOs) are stated qualitatively and quantitatively, where applicable, in the Work Plan for a site investigation or feasibility study. DQOs specify the required quality of data necessary to support decisions related to the program including: site screening, characterization, assessment of health risk, the remedial actions that may take place on a site.

The basis of DQOs is that the quality of data is dependent upon its intended use. DQOs are established based upon site-specific conditions and project objectives and are applicable to all data collection activities.

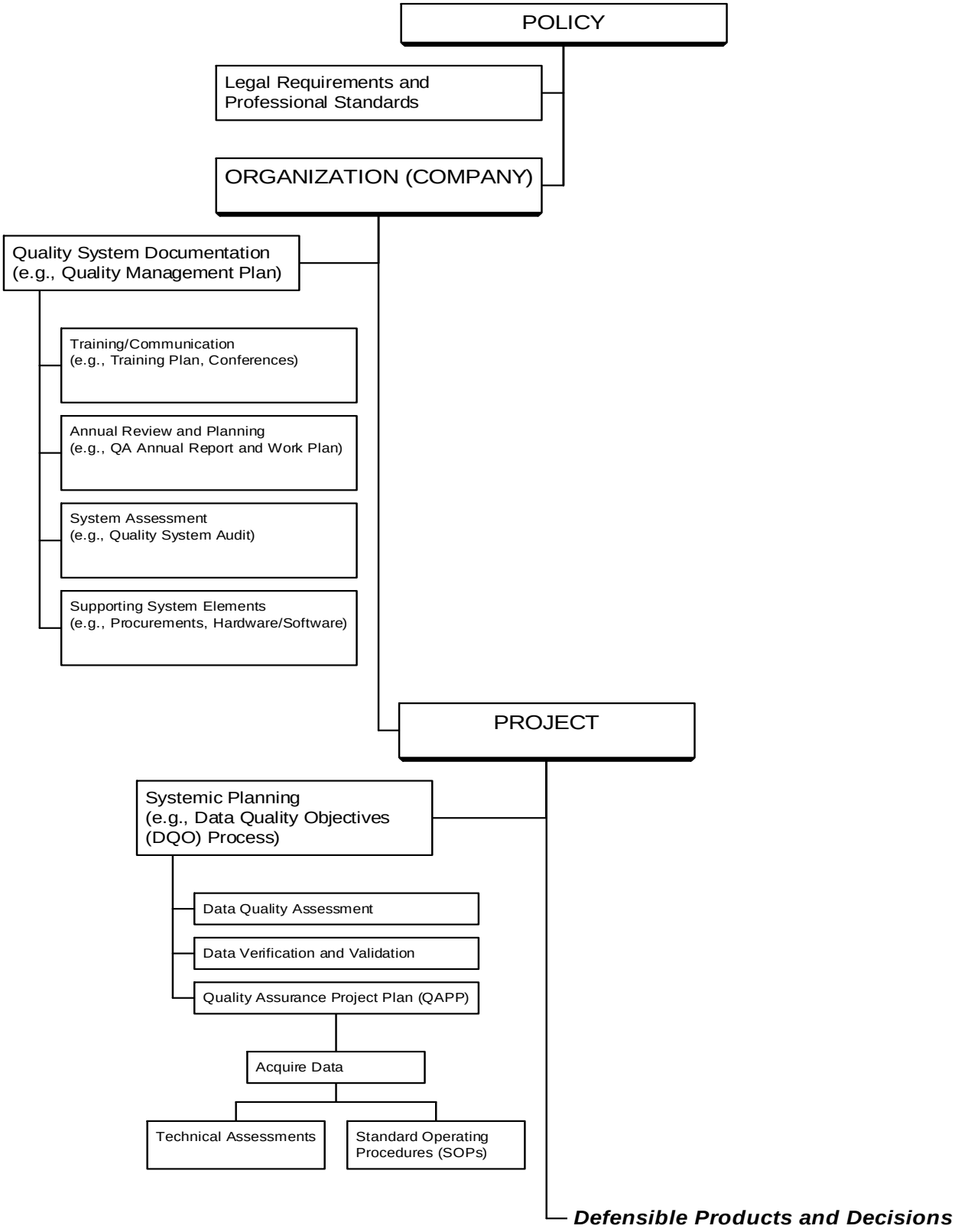
Data quality objectives are developed through an iterative process by which all the DQO elements are continually reviewed and re-evaluated to meet the overall project objectives. This process can be summarized as follows:

Stage 1: Defines the types of decisions which will be made during site remediation by identifying data users, evaluating available data, developing a conceptual model, and specifying goals for the project. Stage 1 results in a specific identification as to why new data are needed.

Stage 2: Identifies the data necessary to meet the objectives established in Stage 1. It also stipulates criteria for determining data adequacy. During Stage 2, sampling approaches and analytical options are evaluated to determine timely or cost-effective approaches.

Stage 3: The final design of the data collection program is established in Stage 3. The design of the data collection program results in the specification of the methods by which acceptable data will be obtained to make decisions.

QUALITY SYSTEM COMPONENTS AND TOOLS



3.2 Data Quality Characteristics

Data quality characteristics will be addressed as they pertain to a proposed investigation. Based on the DQOs selected, data will be assessed and evaluated for:

- Precision
- Accuracy
- Representativeness
- Completeness
- Comparability
- Reporting Limits

The manners in which these characteristics will be assessed and evaluated are described in the following sections.

3.2.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. The duplicate results for each precision check event will be compared to determine the range of the measurements as an indication of the precision associated with the measurement. In addition, the laboratory will analyze matrix spike/matrix spike duplicate samples to monitor the precision of the analytical methods.

Precision will be determined by calculating the relative percent differences (RPD) between the duplicate samples. The RPD for each sample will be calculated using the following equation:

$$\%RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100\%$$

where,
RPD Relative Percent Difference
D_1 First Sample Value
D_2 Second Sample Value (duplicate)

The RPD data will be used to evaluate the long term precision of the analytical/measurement methods. The laboratory will also calculate RPD values on the results of the matrix spike/matrix spike duplicate samples. These RPD values will be compared to RPD values provided in the current NYSDEC ASP protocols.

Procedures to be employed to maximize the precision of the data to be collected include:

- written methods and procedures documented in the project QAPP;
- multiple techniques will not be used to generate or collect the same data;
- all sampling and analytical personnel will be trained and required to follow the Work Plan and QAPP procedures;

- the Field Operations Leader will provide oversight during this investigation to monitor the adherence of project staff to these plans.

3.2.2 Accuracy

Accuracy measures the bias in a measurement system and is a determination of the closeness of the measurement to the true value. Sources of error include the physical sampling process, decontamination procedures, sample preservation and handling, homogeneity of the sample matrix, and sample preparation and analysis techniques used by the laboratory. Accuracy will be measured using blank and spike samples. The levels detected in the blanks and the difference between the reported and known concentrations for spikes will be used to assess the accuracy of the results.

The results of sample spiking will be used to calculate the Percent Recovery (%R), which will be used as the quality control Parameter for accuracy evaluation. Percent Recovery is calculated by the following equation:

$$\%R = \frac{ObservedValue}{TheoreticalValue} \times 100\%$$

Surrogate standard determinations will be performed on all samples and blanks. All samples and blanks will be fortified with surrogate spiking compounds before purging or extraction as specified in current USEPA SW-846 protocols.

Procedures employed to maximize the accuracy of the data to be collected include:

- written methods and procedures documented in the project FSP;
- all sampling and analytical personnel will be trained and required to follow the procedures specified in these plans, use of standard methods and known procedures to generate accurate data;
- adherence to strict decontamination procedures of sampling equipment;
- frequent calibration against known standards of field and laboratory equipment.

Calculations performed with analytical data are also checked for accuracy and precision by the Project Manager, Field Operations Leader or their designees, and reviewed by the Quality Assurance Manager.

3.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent an analytical result from the matrix being sampled. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program.

Procedures employed to maximize the representativeness of the data to be collected include:

- written methods and procedures documented in the project FSP;
- avoiding use of multiple techniques to generate or collect the same data;

- all sampling and analytical personnel to be trained and required to follow the procedures specified in the project plans;
- Field Operations Leader to provide oversight during the investigation to monitor the adherence of project team members to these plans.

In addition, the sampling locations and number of samples to be collected (as specified in a Work Plan) will be selected to provide data representative of the media and potential contaminants of concern at locations where releases would be expected to be detected if present.

3.2.4 Completeness

Completeness is defined as the percentage of data collected judged to be valid and useful to the objectives of the project. Completeness is the amount of valid data obtained from a measurement system expressed as a percentage of the number of valid measurements that should have been (i.e., were planned to be) collected according to the Work Plan. The completeness objective will be 100% valid data for samples collected or analyzed. If this objective cannot be met due to unforeseeable problems, the problems will be addressed in the data usability report. Any data deficiencies will be evaluated in terms of their impact on project goals, and corrective action will be taken, if needed.

Procedures employed to maximize the usefulness and completeness of project data include:

- real-time field screening to focus on potential contaminant source regions;
- soils and groundwater samples for laboratory analysis for confirmation purposes;
- sample handling and shipping procedures which protect samples from breakage;
- communication with the laboratory to ensure their awareness of sample holding times;
- the availability of backup instruments or equipment for field measurements;
- collection of minimum-recommended sample volumes, which frequently include sufficient volume for re-analysis if a problem occurs in the laboratory;
- monitoring of field activities by the Field Operations Leader so as to allow for potential re-sampling or other measures to ensure that the required samples are collected.

3.2.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Methods will be employed during this investigation to ensure that the data generated can be compared to other relevant data sets of similar quality. The analytical results of QA/QC samples and internal laboratory QA/QC samples will be reported along with the results of field sample analyses. Standard sample analysis and reporting methods will follow NYSDEC ASP protocols.

3.2.6 Reporting Limits

Formulae for determining the reporting limits specific to each parameter analyzed are provided by the laboratory.

3.3 Quality Assurance Reports

The Quality Assurance Manager will prepare status reports to summarize QA/QC issues related to the collected data. The objective of the status report is to verify that the work being performed on the project adheres to all of the project plans, and that the collected data meet the previously described goals for precision, accuracy, and completeness.

3.4 Data Quality Requirements

Site specific data requirements are presented in the Work Plan, FSP, or associated documents for a particular project or investigation. There are five general analytical levels of data quality. These levels are described as follows:

Level I: Field screening utilizing portable instruments. These data may include pH, temperature, and specific conductance measurements of water samples, and ambient air and soil screening measurements with photoionization, flame-ionization, O_2, lower explosive limit (LEL), or other meters.

Level II: Field analyses utilizing more sophisticated portable analytical instruments. These instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. Data quality depends on the use of suitable calibration standards, reference materials, sample preparation equipment, as well as the training of the operator. Results from Level II data are available in real-time or within several hours of sample collection.

Level III: These data include analytical laboratory data utilizing USEPA-approved procedures other than ELAP protocols. All analyses are performed in an off-site analytical laboratory following SW-846 protocols. Level III is characterized by rigorous QA/QC protocols and documentation.

Level IV: Analytical laboratory analysis using ELAP methods and supported by a rigorous QA program and documentation. These data are typically used for definitive site characterization, risk assessment, engineering alternative selection and design, and litigation activities. Level IV methods may include pre-approved non-standard methods for specific constituents or detection limits. All analyses are performed in an off-site analytical laboratory.

Level V: These data include physical property and engineering material analysis by approved standard or non-standard methods including analysis of non-standard sample matrices (e.g. wastes, biota). All analyses are performed in an off-site laboratory. The following table presents a summary of analytical levels appropriate to data uses.

Summary of Analytical Levels Appropriate to Data Uses

Data Uses	*Analytical Level*	*Type of Analysis*	*Limitations*	*Data Quality*
Site Characterization. Monitoring during implementation.	Level I	Total organic and inorganic vapor detection using portable instruments, Field test kits	Instruments respond to naturally occurring compounds	If instruments are calibrated and data are interpreted correctly, can provide indication of contamination
Site Characterization. Evaluation of alternatives. Engineering design. Monitoring during implementation.	Level II	Variety of organics by GC; Inorganics by AA; XRF Tentative ID; Analyte-specific; Detection limits vary from low ppm to low ppb	Tentative ID Techniques and instruments mostly limited to volatiles, metals	Dependent on QA/QC steps employed. Data typically reported in concentration ranges.
Risk assessment. PRP determination. Site characterization. Evaluation of alternatives. Engineering design. Monitoring during implementation.	Level III	Organics and inorganics using EPA Procedures other than CPL can be analyte specific RCRA Characteristics tests	Tentative ID in some cases Can provide data of same quality as Levels IV, NS	Less rigorous QA/QC
Risk assessment. PRP determination. Evaluation of alternatives. Engineering design.	Level IV	HSL organics and inorganics by GC/MS; AA; ICP Low ppb detection limits	Tentative identification of non-HSL parameters. Some time may be required for validation of packages	Goal is data of known quality. Rigorous QA/QC.
Risk assessment. PRP determination.	Level V	Non-conventional parameters. Method specific detection limits. Modification of existing methods. Appendix 8 parameters	May require Method Development or Modification. Mechanism to obtain services requires special lead time.	Method specific

Reference: EPA Document No. 540 G-87 003, 1987, "Data Quality Objectives for Remedial Response Activities"

4.0 ENVIRONMENTAL SAMPLING / TESTING PROCEDURES

An essential aspect of any field investigation is assurance that sample collection is conducted in a manner that will provide high-quality, representative data. This section of the QAPP provides a description of sampling techniques, procedures, and equipment used during field sampling programs.

4.1 Site Specific Sampling and Testing Rationale

The Work Plan provides the sampling rationale for every investigation, including the rationale for the following tasks:

- sampling of environmental media,
- determination of constituents to be measured in each environmental media,
- sampling locations,
- sample depths and types,
- number and frequency of samples to be collected.

The specific details of a field investigation such as sampling locations, target depths, analytical methods, and a reference map are detailed in the project Work Plan.

4.2 Documentation

During the implementation of any investigation, field activities will be documented in field log books. The field log book is a controlled document, which records all major on-site activities during the investigation. The log book is a bound notebook with pages that cannot be removed without cutting or tearing pages. Each page of the log book will be numbered consecutively and signed at the bottom of the page with the signature or initials of the person who completed the page. All entries will be made in ink and errors crossed-out with a single line and initialed and dated.

Field data for all tasks completed during this field program, as well as general observations, pertinent conversations, and unexpected occurrences will be documented in field log books. At a minimum, the following information will be recorded:

- Names of personnel on-site (including all subcontractors);
- Date and time of arrival and departure;
- Daily objectives;
- Site name, location, and project number;
- Field observations;
- Weather conditions;
- Site sketch with description of sampling points;
- Health and Safety monitoring data;
- Field calibration, decontamination procedures, and performance frequency;
- Well bailing or pumping procedure and equipment;
- Well specifics including static water level, depth, and volume of water removed;

- Type and quantity of monitoring well construction materials used;
- Surveying data;
- Sample identification numbers;
- Sample point names and descriptions;
- Sample collection procedures and equipment;
- Sample preservation used;
- References to maps or sketches of the sampling site;
- Results of any field measurements, such as pH, water temperature, specific conductivity, and field screening results;
- Notes on conversations with site personnel, observers, or subcontractors;
- Problems encountered and the manner of their resolution;
- General observations that may support the data; and
- Summary of daily activities completed.

4.3 Pre-Sample Planning

The quality of sample collection is maintained by specifying the technique used for both the medium/matrix to be sampled and the analytes of interest. For example, groundwater samples intended for SVOC analyses are collected in amber glass containers; groundwater samples for VOC analyses are collected in Teflon-capped glass vials with no headspace to minimize diffusive and evaporative losses; and groundwater samples for inorganic analyses are collected in polyethylene bottles. Sample containers provided by the analytical subcontractor are prepared in a manner consistent with USEPA protocol.

Acquisition of environmental samples also requires specialized techniques to preserve sample integrity and to ensure that a representative portion of the source is collected. Media-specific sample collection techniques and sample preservation are specified in the following sections.

4.3.1 Sample Labels and Records

Sample labels will be prepared using a pre-determined labeling system. Each sample may require several containers depending on the intended analysis to be performed. At the time the sample is collected, a sample data record sheet and field logbook entries will be completed. The sample documentation may include:

- A plan of the site with the sample location and sample numbers indicated
- A description of the sample site
- Physical descriptors of the sample site, if appropriate (e.g., stream width, groundwater depth, etc.)
- Photographs of the sample site showing the sampling equipment and/or unusual conditions (orientation of photograph must be shown on sketch map, and photo number recorded in field notebook)
- Chain of Custody documentation (see Section 5)

Identification of samples collected during the field investigation will be accomplished using alphanumeric Sample Identification codes indicating sample type, sample identification, depth of

sample (if applicable), and designation of duplicate samples. An explanation of the Sample Identification codes system for soil, groundwater, and sediment samples is shown below:

Sample Identification Code System

Digits	*Identification*	*Description*	*Code/Example*	
1, 2	Site Code	Two letter code to identify the site	FR	Fuller Road
3, 4	Sample Type	Two letter code to identify sample media	SB	Test Boring Soil Sample
			SS	Surface Soil
			BW	Screened-auger Groundwater Sample
			MW	Monitoring Well Groundwater Sample
			SW	Surface Water
			SD	Sediment Sample
			TB	Trip Blank
			EB	Sampler Blank
			SV	Sub-Slab Vapor Sample
			TP	Test Pit Soil
			PW	Test Pit Water
			WT	Waste Sample
			DL	Drum Liquid
			DS	Drum Solids or Sludge
			IA	Indoor Air Sample
			OA	Outdoor Air Sample
			GP	Geoprobe® Soil Sample
			CD	Septic System/Sump Sludge Sample
			CL	Septic System/Sump Catch Basin Liquid Sample
			CB	Catch Basin/Storm Drain Sediment Sample
5, 6, 7	Sample Locator	Three numbers to identify sample site name or location	MW102	Monitoring Well Groundwater Sample from Well 102

Digits	*Identification*	*Description*	*Code/Example*	
8, 9, 10	Depth of Sample Below Reference Surface		SB-XX0	SB samples collected from 0 to 2 feet below ground surface (bgs)
			SB-XX1	SB sample depth is assumed to be the top of a 2-foot, split-spoon sample
			X25	MW sample depth is assumed to be the bottom of the well screen measured in feet bgs
			128	All samples obtained from the ground surface or from drums or containers will be designated XXX
11, 12			XX	Duplicates will periodically be sent to the lab with the XX designation to preserve duplicate anonymity, according to Section 9.2.
			XF	Sample collected for field analysis or future reference
			XD	Duplicate sample
			MS	Matrix spike
			MD	Matrix spike duplicate
			XS	Laboratory split sample

4.3.2 Sample Container Requirements and Sample Preservation

Sample integrity will be maintained by using special containers and preservation methods keyed to both the medium/matrix to be sampled and the analytes. Sample containers and preservation methods specified in NYSDEC protocols are summarized in the table below. Any changes to these protocols required by a specific project will be detailed in a site-specific Work Plan.

4.3.3 Preparation of Sample Containers

Sample containers will be provided by the laboratory and are prepared according to USEPA protocols. The bottles will be equivalent to I-Chem series 300. QC records for the bottles used will be maintained by the laboratory. The preparatory procedures used by the vendor providing the laboratory with sample containers are detailed below.

4.3.3.1 Volatile Organic Analyte (VOA) Containers

(40-mL glass vials and 2-oz or 4-oz glass jars)

1. Wash vials, septa, and closures in hot tap water with laboratory grade non-phosphate detergent.
2. Rinse three times with tap water.
3. Rinse three times with ASTM Type II water.
4. Oven dry vials, septa, and closures.

5. Remove vials, septa, and closures from oven.
6. Place septa in closures, Teflon side down, and place on vials. The attendant must wear gloves and the vials cannot be removed from the preparation room until sealed.

4.3.3.2 Semi-Volatile Organic Analyte (SVOA) Containers

(1-liter amber glass bottles and 4-ounce glass jars)

1. Wash containers, closures, and Teflon® liners in hot tap water with laboratory grade non-phosphate detergent.
2. Rinse three times with tap water.
3. Rinse with 1:1 nitric acid.
4. Rinse three times with American Society for Testing and Materials (ASTM) Type II water.
5. Rinse with pesticide-grade methylene chloride.
6. Oven dry.
7. Remove containers, closures, and Teflon® liners from oven.
8. Place Teflon liners in closures and place closures on containers. The attendant must wear gloves and the containers cannot be removed from the preparation room until sealed.

4.3.3.3 Metals Containers

(1-liter, 500, 250, 120 and 60-milliliter (mL) clear and 1-liter amber polyethylene bottles)

1. Wash bottles, closures, and Teflon® liners with hot tap water and laboratory grade non-phosphate detergent.
2. Rinse three times with tap water.
3. Rinse with 1:1 nitric acid.
4. Rinse three times with ASTM Type II water.
5. Air dry in contaminant-free environment.
6. Place liners in closures and place closures on bottles. The attendant must wear gloves and the bottles cannot be removed from the preparation room until sealed.

4.3.3.4 Sample Preservation

Samples are preserved according to the protocol established for the selected analytical method. Unless the proper sample container preparation and sample preservation measures are taken in the field, sample composition can be altered by contamination, degradation, biological transformation, chemical interactions, and other factors during the time between sample collection and analysis.

Steps to maintain the in-situ characteristics required for analysis may include storage of samples at 4°C, pH adjustment, and chemical fixation. Specific sample and container preservation requirements are detailed in Table 3 above. Where pH adjustment is performed, the pH will be checked in the field with pH paper to ensure the required pH level is achieved. If pre-preserved sample containers are provided by the laboratory, extra preservation material should be available in the field in case it is needed to achieve the target pH.

Table 3 - Summary of Required Containers, Preservation Requirements and Holding Times

Parameter	*Matrix*	*Required Container*	*Minimum Volume* *Required for Analysis*	*Preservation Technique*	*Holding Time (2)*
Volatile Organics (3)	Water	Glass vials with Teflon faced septa and screw cap. (Two 40 ml vials per sample)	50 ml	Cool (4°C) Preserved with acid (HCl to pH<2)	7 days
	Soil	2-2oz or 1-4oz wide-mouth glass jar with Teflon-lined cover.	10 grams	Cool (4°C)	7 days
Semi-Volatiles, Pesticides, PCBs (3), or Total Petroleum Hydrocarbons	Water	1-L Amber glass jar with Teflon lined screw cap.	1,000 ml (1 Liter)	Cool (4°C)	Extraction within 5 days of sampling. Analysis within 40 days of extraction
	Soil	8-oz wide mouth glass jar with Teflon-lined cover	50 grams	Cool (4°C)	Extraction within 5 days of sampling. Analysis within 40 days of extraction
Metals (Total and Dissolved) (1) (4)	Water	Polyethylene bottle (one 1 L bottle)	100 ml	(Dissolved metals only - field filtered using 0.45 micron filter) Cool (4°C) Preserved with acid (HNO_3 to pH<2)	180 days
	Soil	8-oz wide mouth glass jar with Teflon-lined cover	10 grams	Cool (4°C)	180 days
Total Petroleum Hydrocarbons Fingerprint Analysis	Water	Glass jar with Teflon lined screw cap (one 1 L bottle)	1,000 ml (1 Liter)	Cool (4°C)	28 days
	Soil	8-oz wide mouth glass jar with Teflon-lined cover	50 grams	Cool (4°C)	28 days
Total Cyanide	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C) Preserved with base (NaOH to pH>12)	180 days
	Soil	8-oz wide mouth glass jar with Teflon-lined cover	10 grams	Cool (4°C)	12 days
Mercury (Total and Dissolved)	Water	Polyethylene bottle (one 1 L bottle)	100 ml	(Dissolved metals only - field filtered using 0.45 micron filter) Cool (4°C) Preserved with acid (HNO_3 to pH<2)	26 days
	Soil	8-oz wide mouth glass jar with Teflon-lined cover	10 grams	Cool (4°C)	26 days
Biochemical Oxygen Demand	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C)	24 hours
Bicarbonate	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C)	14 days
Carbonate	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C)	14 days
Chemical Oxygen Demand	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C) Preserved with acid (H_2SO_4 to pH<2)	26 days
Chloride	Water	Polyethylene bottle (one 1 L bottle)	100 ml	None Required	26 days
Sulfate	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C)	28 days
Total Dissolved Solids (TDS)	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C)	7 days
Total Suspended Solids (TSS)	Water	Polyethylene bottle (one 1 L bottle)	100 ml	Cool (4°C)	5 days

Reference: EPA Document No. 540 P-87 001, 1987, "A Compendium of Superfund Field Operations Methods"
NOTES: (1) Metals analysis will be conducted on unfiltered samples. If filtered samples are analyzed, unfiltered samples must also be collected and analyzed. If turbidity presents a problem, the samples will be handled according to NYSDEC "Guidelines for Handling Excessively Turbid Samples" following approval by the Division of Hazardous Waste Remediation (DHWR). (2) Holding times are calculated from VTSR (Verified Time at Sample Receipt). Samples must be received by the lab within 48 hours of collection. (3) TCL = Target Compound List. (4) TAL = Target Analyte List.

4.4 Decontamination Procedures

Standardized procedures for decontamination have been established to reduce the likelihood of cross-contamination between samples and sampling locations. Equipment to be decontaminated includes: backhoes, drilling equipment, and sampling equipment.

All decontamination procedures will comply with the personal protection requirements detailed in the site Health & Safety Plan (HASP). Personal protection levels will depend on the nature of the contamination and the specific decontamination method. Specific decontamination methods for exploratory and sampling equipment are described in the following sections.

4.4.1 Heavy Equipment

Heavy equipment such as drill rigs and backhoes may need to be steam cleaned with a portable high pressure steam cleaner upon arrival at the site and prior to demobilization. During the course of investigation activities, it is only necessary to decontaminate equipment that comes in contact with soils and/or groundwater (i.e., drill rods, bits, backhoe bucket, etc.).

Prior to initiation of drilling activities at the site, a temporary steam cleaning area will be established, if necessary, for the decontamination of the drill rig and associated tools and augers. When selecting the steam cleaning location, the following items will be considered:

- Free from traffic;
- Away from any proposed test boring or monitoring well locations;
- Readily accessible to the investigation area; and
- Free of known surficial contamination.

The decontamination area will consist of a controlled area or structure to contain all wash water and eliminate the possibility of drilling equipment coming in contact with the underlying surficial soils and/or pavement during steam cleaning. Site-specific decontamination area construction requirements may be detailed in the Work Plan.

All equipment will be placed on clean pallets or racks prior to and after steam cleaning. Potable water will be used for the steam cleaning activities. The equipment to be steam cleaned includes: drill rods, augers, bits, tools, and split-spoon samplers. Decontamination wastewater and soils will be initially drummed into 55 gallon steel containers or other appropriate holding vessels pending laboratory analyses.

4.4.2 Drilling Equipment

Drilling equipment that is exposed to soil and/or groundwater will be steam cleaned between sampling locations. The purpose of this decontamination is to ensure that potential contaminants are not transferred between sampling locations.

4.4.3 Sampling Equipment

Contaminated tools and sampling equipment will be placed in a plastic pail, tub, or other container with a Liquinox® (or equivalent) soap and water solution. The tools will be brushed off, rinsed, and transferred to a second soap and water solution bath. Tools will be rinsed with potable water and finally rinsed with de-ionized water. Tools such as wrenches, split-spoons, etc., may be decontaminated between exploration locations with a high-pressure steam cleaner instead of washing. Sampling equipment such as reusable bailers or submersible pumps will be wrapped in aluminum foil after cleaning to prevent contamination before their next use. Control and disposal of decontamination fluids are discussed in Section 4.4.4

4.4.4 Control and Disposal of Decontamination Materials

In general, The Chazen Companies is responsible for collecting, controlling, and staging material generated during field investigations. Disposal arrangements will be made for the client, if required, for particular work assignments. Specific procedures for handling contaminated environmental materials and contaminated personal protective equipment will be presented in the Work Plan and/or the HASP.

Contaminated soil and water will be handled according to NYSDEC Technical Guidance for Site Investigation and Remediation (DER-10) (dated November 2009) unless otherwise specified in the Work Plan. These documents describe alternatives for disposal of these materials and requirements for handling.

4.4.4.1 Soil Disposal

Drill cuttings and soils generated during investigation activities are presumed to be contaminated. Alternatives for on-site disposal of investigation derived soils include:

- Backfill inside the borehole that generated the soil, with the top 12 inches consisting of clean cohesive, compacted soil, or to depth that allows restoration of paved surface, whichever is applicable. Soil can not be used to backfill boreholes if it contains free product, non-aqueous phase liquid or is grossly contaminated; if a well will be installed in the borehole, if the borehole penetrated an aquitard, aquiclude, or other confining layer or extends into bedrock; or if backfilling the borehole with soil cutting will create a significant path for vertical movement of contaminants.
- Containerize and temporarily store on-site prior to off-site disposal;
- Transport from off-site areas to site (without need to manifest or contract with licensed hauler).

Hazardous soils can be sent off site for disposal to a properly permitted treatment, storage, or disposal facility, and non-hazardous soils can be sent to a solid waste management facility. Representative samples of materials will be analyzed for proper classification, treatment, and disposal. Materials will be transported by a licensed hauler and accompanied by the proper manifests.

Disposal alternatives are subject to precautions listed in DER-10 Section 3.3(e). Specific handling and disposal requirements for drill cuttings will be identified by the Field Operations Leader based on field screening and analytical results of drill cutting samples, if applicable.

4.4.4.2 Groundwater Disposal

The control of contaminated groundwater is important to prevent impacts to surficial soils. Alternatives for the disposal of groundwater generated during sampling at hazardous or petroleum impacted sites are generally recognized and are provided below:

- Transportation off-site to an authorized disposal/treatment facility;
- Discharge to a sanitary sewer for treatment at a publicly-owned treatment works (POTW);or
- Transport by truck to a POTW.

In order to determine the proper disposal option for groundwater generated during monitoring well development and purging, the water will be containerized pending the receipt of laboratory analysis.

4.4.5 Sample Handling/Shipping Areas

Sample containers will be wiped clean at the sample site, taken to the decontamination area to be further cleaned, as necessary, and transferred to a clean carrier. The sample identities will be checked off against the COC record. The samples will then be stored at approximately 4° C in a secure area prior to shipment.

Sample handling areas will be cleaned/wiped down daily. For final cleanup, all equipment will be disassembled and decontaminated. Equipment that cannot be satisfactorily decontaminated will be disposed of.

4.4.6 Monitoring Equipment

When monitoring equipment is used under conditions where contamination is possible, the equipment will be protected from contaminant sources by draping, masking, or otherwise covering as much of the instrument as possible with plastic without hindering the operation of the unit.

Any contaminated equipment will be taken from the source area and the protective coverings removed and disposed of in appropriate containers. Any direct or obvious contamination will be brushed or wiped with a disposable paper wipe. The units will then be dried, checked, and calibrated for subsequent operations.

4.5 Air Monitoring

The air monitoring program is designed to provide the necessary information to ensure the safety of on-site personnel and to evaluate potential increases to air contaminant levels and dispersion patterns during site activities. Air monitoring will be conducted during field activities as detailed in the site-specific HASP and/or Work Plan.

4.5.1 Site Safety Air Monitoring

The required level of personal protection equipment specified in the site-specific HASP will be verified by the results of air quality screening performed on-site during field activities. The screening will be performed using a photoionization detector (PID) which detects and measures concentration levels of total VOCs relative to a reference standard on a real-time basis. The PID lamp sensitivity will be specified in the site-specific HASP based on any information regarding identification of potential contaminants. Most sites will require a PID with a lamp of 10.2 or 11.7 electron volts (eV).

The HASP outlines the air monitoring procedures to be followed during the field investigation. Air monitoring equipment used on site may include a PID, chemical indicator tubes (e.g., Draeger® tubes), percent oxygen/lower explosive limit meter, respirable dust monitor, or a radiation detector.

In addition to work place air monitoring, the Community Air Monitoring Plan (CAMP) will be implemented to document air monitoring for perimeter areas. The CAMP is provided in Appendix E of the Work Plan.

4.6 Field Screening

4.6.1 Soil Jar Headspace Testing

Headspace vapor monitoring will be performed as a screening tool for determining the relative concentrations of VOCs in soil samples. A photoionization-detector (PID) and/or flame ionization detector (FID) will be used. The PID/FID will be calibrated daily in accordance with manufacturer's specifications. Headspace readings will be collected using the static headspace analysis method detailed below:

- Approximately 2 oz. of soil will be collected from each open split-spoon or Geoprobe Macrocore sampler and placed in a dedicated laboratory-cleaned glass jar. Alternatively, soil may be placed in a resealable plastic bag which will be immediately sealed. The mouth of the jar will then be immediately covered with aluminum foil prior to sealing the jar lid to minimize the loss of VOCs. Headspace samples will be collected for each split spoon sample.
- The jar will be shaken to break up the compacted soil or material, and will be placed in a specified location (e.g., field vehicle), out of direct sunlight, for a period of no less than 15 minutes to equilibrate prior to field monitoring.
- Where ambient temperatures are below 0^{o}C, headspace development should be within a heated vehicle or building. Ambient temperature during headspace analysis will be recorded and reported.
- The jar lid will be removed from the jar. Headspace will be monitored within the jar by piercing the aluminum foil with the PID probe. Care will be taken to prevent unnecessary mixing of jar headspace and outside air. Monitoring with the PID will continue until a stable reading is shown or the readings have peaked and subsequent readings are decreasing. The highest concentration observed will be recorded along with the sample interval in the field notebook and on the Soil Boring Log.

4.6.2 NAPL in Soil Field Screening

Field screening of soil in the source area will also be field screened using a hydrocarbon and NAPL screening test kit such as the dual dye Oil-In-Soil™. The kit instructions will be followed and are included in the attachment. Field screening soil for DNAPL will follow the kit instructions which are summarized as follows.

- Place soil in the bottle to the line "Fill soil to HERE." Do not compact the soil.
- Add potable water to the bottle to the line "Fill water to HERE." Ensure that water is warm enough (68 ºF or warmer) to dissolve the dye cube.
- Replace cap on the bottle and shake jar until cube is **completely** dissolved.
- Assess the color of bottle contents. Red liquid or spots on the side of the bottle will appear within 30 to 60 seconds in DNAPL or petroleum are present in the sample. The water will be green, to provide color contrast with the red. If color is not immediately apparent in the jar, check the polystyrene ball, sides of the bottle and the layer beneath the water layer. If the ball has ANY color (even a faint pink halo or hue) this indicates the presence of more than 500 ppm total petroleum hydrocarbons (TPH) in that sample. If there is no color on the ball, TPH is less than 500 ppm.
- Record field screening readings findings using the Endelman Score© symbols

Explanation of the Edelman Score© Symbols

Score	Explanation
++	Very strong reaction. For chlorinated compounds the soil is stained red as well as the plastic walls of the test kit. For petroleum materials the soil is stained red as well as having a red colored meniscus on the surface of the water in the kit (i.e., some NAPL was extracted).
+	Positive reaction (greater than approximately 10% red coloration of soil for chlorinated compounds or any red coloration for petroleum)
+/-	A few soil grains are stained red for chlorinates and/or the Styrofoam float ball in the test kit is stained red or pink. For petroleum, the Styrofoam float is stained red or pink.
-	No reaction.

- Dispose of the kit with other IDW.

4.6.2 Portable Gas Chromatograph

Field screening of soil may also be conducting using a portable gas chromatograph (GC). This screening method allows for field identification of VOCs and facilitates selecting samples for laboratory analysis. The SRI Model 8610 and other, similar portable gas chromatographs (GCs) are used for field and laboratory screening of air, soil gas, water, and soil headspace samples for volatile organic compounds. The SRI Model 8610 utilizes both a photoionization detector (PID) and a dry electrolytic conductivity detector (DELCD) to monitor for a wide range of chlorinated

and non-chlorinated compounds and aromatic hydrocarbons. Resolution of 1 part per billion (or 1 ug/l) is possible using GC analytical techniques. When utilizing a portable GC, both standard operating procedures and variances from the standard are to be documented in the operators' written log.

Similar to other field screening methods, a subsample is collected from the soil sample. A 40-mL glass vial is half-filled with soil and the cap is secured before the vial is placed in a heated water bath at a constant 80 ºC temperature. Then a gas-tight syringe is used to extract a 1 cubic centimeter (cc) sample (0.1 cc if high contaminant concentrations are present) and to introduce the sample onto the capillary column of the GC. As the sample travels through the length of the column, some of its chemical constituents are readily adsorbed to the column and are retarded while others are not as readily adsorbed to the column and elute more rapidly. This achieves separation at the detector end of the column. Variations in column length as well as temperature and pressure within the GC can increase or decrease chemical separation within the column. It is necessary to strike a balance between separation of retention times and total analytical run time in order to achieve a high level of productivity in the field while still realizing meaningful results. This is primarily achieved by altering the temperature program on the GC.

As compounds elute, they first reach the PID. Because it is non-destructive, it is often run in series with other detectors for multiple levels of detection from a single injection. The SRI Model 8610 contains a 10.8 eV PID. Aromatic hydrocarbons and most compounds with a carbon double bond are readily detected by the PID, while chlorinated solvents generally have ionization potentials greater than 10.8 and are not detected by the PID.

The DELCD is useful for low-level detection of chlorinated and brominated solvents. The DELCD is mounted after the PID in series on the GC column.

The detection levels are reported as voltage response vs. time to a serial port on the GC. A portable PC connected via serial cable to the GC is utilized to operate the GC and record the detection data. Detected compounds appear as positive voltage "peaks" on the chromatographs. Qualitative identification of compounds with a GC is based on a comparison of retention times to those of known standards. Quantification of compounds is based on a comparison of peak areas (areas under the peak) to those of known standard concentrations.

While portable, the GC is best utilized in a stable, temperature controlled environment. The instrument is not designed to be exposed to precipitation. High humidity ambient air may also cause deleterious effects. These problems can be avoided by operating the GC inside of a vehicle (cargo van) where the climate can be controlled.

4.7 Borings and Environmental Wells

4.7.1 Drilling Methods

Soil borings will be drilled to facilitate collection of subsurface soil samples for geologic classification, chemical analyses, and physical testing. Drill rigs are utilized to advance the borings. The rigs are typically mounted on trucks, all-terrain vehicles, or skids. There are a variety of drilling methods that may be utilized including direct push, hollow-stem auger (HSA), drive and wash, and mud rotary. Each of these methods enables the collection of soil or

groundwater samples. Drilling methods also facilitate the installation of monitoring wells to provide hydrogeologic data.

A geologist will observe drilling operations summarizing boring information in a field notebook, taking photographs when appropriate, and collecting samples in accordance with the Field Sampling Plan. A boring log will be prepared that includes: characterization of subsurface materials and geologic conditions, air monitoring readings, field screening readings, pertinent drilling information, and relevant observations (i.e., staining, odor, sheen, etc.). An example of a typical boring and monitor well log is presented below.

Typical Boring Log

THE Chazen COMPANIES

PROJECT:
LOCATION:
CLIENT:
PROJECT NO.:

Test Boring No.: **MW-6**

Total Depth: ft.

Contractor:
Drill Rig:
Driller:
Inspector:

Start Date:
Finish Date:
El. Datum:
G.S. Elevation:

Northing:
Easting:
Longitude:
Latitude:

Borehole Dia.: in.
Depth to Water: ft.
Depth to Rock: ft.
Depth of Well: ft.

Depth *(Feet)*			Elevation *(Feet)*	Casing Data	Sample No.	Sample Data	Recovery *(Inches)*	PID *(ppm)*	Group Symbol	Stratum and Field Descriptions:	Well Diagram	Field Notes, Well Notes, Comments:
					S1	9	5	0		0-3" Asphalt		
1			-1			8				3-6" Gravel road base		
						5				6"-11" Fill - Black, ash, wood, dry, no odor		
2			-2			5						
					S2	8	5	0		2'-2'5" Fill - Black ash, wood, gravel, tip of spoon wet, no odor		
3			-3			2 4						
						8						
4			-4			7						
					S3	6	3	0		4'-4'3" Black, silty CLAY, saturated, no odor		
5			-5			3						
						1						
6			-6			1						Bentonite:
					S4	3	12	0		6'-6'3" Same as above		Sand:
7			-7			8				6'3"-7' Reddish brown, silty CLAY, gravel, saturated, no odor		
						4						
8			-8			3						
					S5	4	12	0		8'-9' Dark brown and reddish brown, plastic CLAY, saturated,		
9			-9			1				no odor		
						1						
10			-10			2						
					S6	2	12	0		10'-11' Dark brown, silty CLAY, moist to wet, no odor		
11			-11			3						
						2						
12			-12			4						
										Boring terminated at 12 feet below ground surface		
14			-14									

ADDITIONAL NOTES:

Drilling methods used during an investigation will be determined in advance and will be detailed in the Work Plan with the provision that the drilling procedure may be modified in response to conditions encountered during drilling. A more detailed discussion of the various drilling methods, sampling procedures, and well installation procedures is provided below.

4.7.1.1 Hollow-Stem Augers

The Hollow Stem Auger (HSA) method utilizes coupled lengths of continuous-flight, hollow steel augers to advance through overburden materials. With this method, drill cuttings rise upward on the flights as the string of augers is rotated.

Typically, $4^1/_4$-inch or $6^1/_4$-inch inner diameter (ID) augers are used for hazardous waste investigations. These produce nominal 8-inch and 10-inch boreholes, respectively.

A center plug equipped with cutting teeth is attached to drilling rods and placed inside the augers to facilitate cutting and to prevent subsurface materials from entering the augers.

When the augers are advanced to the appropriate depth, the center plug is removed to allow for the collection of soil or in situ samples.

The advantage of the HSA method is that limited fluid use is required. In addition, 2-inch ID monitoring wells can be easily installed inside the augers. The limitations of HSA drilling include the inability to advance through very dense materials like rock, cobbles, rubble, etc., or drilling through loose saturated sands and silts which tend to flow around the plug and seize the tooling. Drilling depths are usually limited to the first dense rock layer encountered or by the torque of the machine.

4.7.1.2 Direct Push

Soil probing or "direct push" machines such as the Geoprobe® push tools and sensors into the ground without the use of rotation to remove soil and to make a path for the tool. A Geoprobe® relies on a relatively small amount of static (vehicle) weight combined with a hydraulic hammer as the energy for advancement of a tool string. Probing tools do not remove cuttings from the probe hole but depend on compression of soil or rearrangement of soil particles to permit advancement of the tool string. The attachment includes Geoprobe® standard operating procedures for dual tube and Macro-Core® sampling. These tooling options may be used for sites where boreholes collapse and/or where discrete sampling is needed.

Probing tools are advanced as far as possible using only the static weight of the carrier vehicle. Greater depth is achieved using the combined effect of the vehicle weight and hydraulic hammer. Hammering is often required when probing near the ground surface to penetrate hard-packed surface soil and other hard surfaces. The probe is then allowed to penetrate using only static force until refusal is again encountered, at which time the hammer is reapplied. The hammer is applied as required when probing through sands, gravels, high friction clays, tills, fill materials, and surface frost.

A Geoprobe® can be used to drive tools to obtain continuous soil cores or discrete soil samples; obtain groundwater samples or soil gas samples; install permanent sampling implants and air sparging points; set small diameter permanent monitoring wells; or drive a conductivity sensor probe to map subsurface lithology. Soil probing equipment is typically used for site investigations to depths of 30 to 60 feet.

The advantage of using a Geoprobe® versus conventional drilling techniques, are:

- Minimal cuttings are generated. This reduces handling, containing, storing, sampling, analyzing, and disposing of potentially hazardous and contaminated cuttings. This also reduces disposal costs and potential exposure of site workers, facility employees, residents, and surroundings to hazardous contaminants.

- Only a small diameter hole is created. Grouting is less expensive because a small volume of grouting material is required.

- Less obtrusive equipment required. Small, light, probing equipment is used for sample collection which allows the operator to reach many locations not accessible to larger and heavier drilling equipment.

- Minimal physical disturbance of the sample materials occurs.

- Typical penetration rates are from 5 to 25 feet per minute, although probing time is highly dependent upon soil conditions.

- Sampling time is shorter; therefore, more sample locations can be sampled per day, depending upon soil conditions.

- The unit can sample all subsurface media including soil, groundwater, and soil gas; log soil conductivity and contaminants; grout probe holes; and inject remediation materials.

4.7.2 Subsurface Soil Sampling

4.7.2.1 Split-Spoon Sampling

Split-spoon samplers are used to collect soil samples from the bottom of a borehole. The sampler consists of a thick-walled, steel tube that is split lengthwise. It has a cutting shoe attached at the lower end and a check valve at the upper end.

When needed, the split-spoon sampler is attached to drill rods with a threaded adapter. The split-spoon sampler is driven into the ground in accordance with the standard penetration test (ASTM D1586). The standard penetration test (SPT) consists of driving a $1^{3}/_{8}$-inch ID, 2-foot split-spoon 24 inches into the soil using a 140-pound hammer falling 30 inches. The number of blows required to drive the split-spoon each 6 inches is recorded to obtain the SPT-N value, which is defined as the total blows for the penetration from 6 to 18 inches. Often, larger split-spoons are used in order to provide sufficient soil volume when collecting samples for chemical analyses. The size of the split-spoon and the sampling interval are detailed in the FSP.

After the sampler has been retrieved, a field geologist will perform field screening, soil characterization, and sample collection according to the following procedures:

1. The split-spoon will be screened for VOCs immediately upon opening with a total VOC analyzer such as a PID. The instrument will be passed over the sample while slightly disturbing the soil with a sampling trowel or spoon.
2. The soil from the split spoon will be characterized in the field using Modified Burmeister Soil Classification System or the Unified Soil Classification. Physical characteristics such as color, grain size, soil type, texture, consistency, and moisture will be recorded in a field notebook or boring log form.
3. Representative soils will be placed into the appropriate jars for physical and chemical testing. The type and frequency of tests that will be performed are discussed in the FSP. Samples that may be submitted for laboratory analysis will be placed immediately into laboratory-supplied jars with a pre-cleaned stainless steel trowel or spoon. The samples will be labeled with the date and time of sampling, sample identification and site location, then packed for shipment to the laboratory in a cooler with ice. An 8-ounce jar and/or 40-ml vial will also be filled (if specified in the Work Plan) for soil jar headspace tests as detailed in Section 4.6.1.
4. The split-spoon and sampling utensils will be decontaminated between each sample according to the procedures outlined in Section 4.4.3.

4.7.2.2 Geoprobe® Sampling

Macro-Core Soil Samples

The MacroCore® Soil Sampler is a solid barrel, direct push device for collecting continuous core samples of unconsolidated materials at depth. The standard MacroCore® Sampler has an assembled length of approximately 52 inches (1,321 mm) with an outside diameter (OD) of 2.2 inches (56 mm). Collected samples measure up to 1,300 ml in volume in the form of a 1.5-inch by 45-inch (38-mm by 1,143-mm) core contained inside a removable liner. The MacroCore® Sampler may be used in an open-tube or closed-point configuration. It has a removable/replaceable, thin-walled liner tube inserted inside for the purpose of containing and storing soil samples. The standard MacroCore® liner is 1.75-inches OD by 46-inches long (44-mm by 1,169-mm). Liner materials include stainless steel, Teflon®, PVC, and PETG.

To obtain a soil sample, an assembled MacroCore® Soil Sampler is driven one sampling interval into the subsurface and then retrieved using a Geoprobe® soil probing machine. The collected soil core is removed from the sampler inside a liner.

The MacroCore® Soil Sampler is most commonly used as an open-tube sampler. In this configuration, coring starts at the ground surface with a sampler that is open at the leading end. The sampler is driven into the subsurface and then pulled from the ground to retrieve the soil core. In stable soils, an open-tube sampler is advanced back down the same hole to collect the next core.

In unstable soils, which tend to collapse into the core hole, the MacroCore® Sampler can be equipped with a piston rod point assembly. The point fits firmly into the cutting shoe and is held in place by a piston rod and stop-pin. The MacroCore® Piston Rod System prevents collapsed soil from entering the sampler as it is advanced to the bottom of an existing hole, thus ensuring collection of a representative sample.

Loose soils may fall from the bottom of the sampler as it is retrieved from depth. Better recovery is obtained when the core catcher is used with saturated sands and other non-cohesive soils. A core catcher should not be used with tight soils as it may actually inhibit sample recovery.

Large Bore Soil Sampler

The Large Bore (LB) Soil Sampler is a solid-barrel, piston-sealed, direct push device for collecting discrete interval samples of unconsolidated materials at depth. The assembled Large Bore Sampler is approximately 30-inches long with an OD of 1.5-inches. Collected samples measure up to 283-ml in volume in the form of a 1.0-inch by 22-inch core contained inside a removable liner. It has a 1.15-inch OD by 24-inch long removable/replaceable, thin-walled tube liner inserted inside for the purpose of containing and storing soil samples. Liner materials include brass, stainless steel, Teflon®, and clear plastic (cellulose acetate butyrate).

The Large Bore Sampler is used primarily as a discrete interval sampler; that is, for the recovery of a sample at a prescribed depth. In certain circumstances, it is also used for continuous coring.

To obtain a sample, the assembled Large Bore Sampler is connected to the leading end of a Geoprobe® rod and driven into the subsurface using a Geoprobe® Soil Probing Machine. Additional probe rods are connected in succession to advance the sampler to depth. The sampler remains sealed (closed) by a piston tip as it is being driven. The piston is held in place by a reverse-threaded stop-pin at the trailing end of the sampler. When the sampler tip has reached the top of the desired sampling interval, a series of extension rods, sufficient to reach depth, are coupled together and lowered down the inside diameter of the probe rods. The extension rods are then rotated clockwise using a handle. The male threads on the leading end of the extension rods engage the female threads on the top end of the stop-pin, and the pin is removed. After the extension rods and stop-pin have been removed, the tools string is advanced an additional 24 inches. The piston is displaced inside the sampler body by the soil as the sample is cut. To recover the sample, the sampler is retrieved from the hole and the liner containing the soil sample is removed.

4.7.3 Monitoring Well Installation

This section outlines the general procedures and typical materials utilized for monitoring well installation. The number, location, and construction details of monitoring wells will depend on the project objectives and will be discussed in the Work Plan.
Well construction materials consist of well screen, riser pipe, sand pack, bentonite seal, cement grout, and protective casing. Specific monitoring well details may be outlined in the Work Plan. Typical well construction specifications are described below.

Well Screen and Riser Pipe

The most common materials used in the construction of monitoring wells are polyvinyl chloride (PVC) and stainless steel. Generally, PVC is used because it is less expensive and non-corrosive. However, PVC may deteriorate as a result of certain compounds. In such cases, stainless steel may be preferred. Riser pipe and well screen is typically 1-inch or 2-inch ID and has flush joint threads.

When PVC is used, wells constructed in unconsolidated materials less than 100 feet deep are constructed with Schedule 40 PVC.

Well screens are used in the construction of monitoring wells to limit sediment from entering the well. Generally, screens are machine slotted at slot sizes of 0.01 inches (10-slot) for fine materials or 0.02 inches (20-slot) for coarse materials such as coarse sand and gravel. The screen slot size should be selected to retain 90 percent of the filter pack material or native aquifer material.

Sand Pack

The sand pack consists of uniformly graded sand. A grade of sand is selected such that it will not pass through the well screen and will exclude the fines from the formation. At least a 2-inch layer of sand will be placed at the bottom of the hole prior to the well installation. Sand will be placed around the well screen to a level of 2 feet above the top of the screen. In situations that require a well to straddle a shallow water table, it may be necessary to place less sand above the top of the screen to allow enough space for an adequate bentonite seal.

If there is difficulty with well installation, a well screen that is pre-packed with a layer of sand may be used.

Bentonite Seal

The bentonite seal may consist of pure Wyoming sodium bentonite chips, pellets, or slurry. A bentonite seal expands by absorbing water, and due to its low permeability, serves to isolate the screened interval from the rest of the borehole. The bentonite seal should be at least 2 feet thick and be placed directly above the sand pack. It may be necessary to install less bentonite for shallow water table wells. Bentonite seals that are placed above the water table should be hydrated with potable water. For deeper installations it is often more practical to tremie a bentonite slurry. In such cases, the bentonite slurry may be placed up to the ground surface in place of cement or cement-bentonite grout.

Cement-Bentonite Grout

Grout is placed from the top of the bentonite seal to the ground surface via the tremie method. Generally, grout consists of a cement-bentonite mixture. Cement is Portland Type 1, in conformance to ASTM specifications C150. The bentonite is powdered Wyoming sodium bentonite. Cement-bentonite grout typically consists of 94 pounds of cement mixed with 3 to 5 pounds of powdered bentonite and 7 gallons of water or a media approximating this mixture. The purpose of the grout seal is to replace material removed from the borehole during drilling and

prevent collapse and subsidence around the well. Pure bentonite slurry may also be used in place of the cement-bentonite grout.

Protective Casings

Protective casings are placed around wells to prevent damage, provide security, and to provide a seal to prevent surface runoff from entering the well. They usually consist of a 4- or 6-inch diameter steel casing with a 2-3 foot stick up above the ground or a manhole road box installed flush to the ground surface (flush-mounted casing). The casings should be watertight and equipped with a locking cover. All protective casings should be labeled with the well identification. A concrete surface seal should be constructed around the protective casing at the ground surface to provide a seal and to divert surface runoff away from the well. All details of well installation will be recorded by the geologist.

4.7.4 Well Development

Monitoring wells will be developed in order to restore the natural permeability of the formation adjacent to the borehole and to permit water to flow through the screen easily. Well development removes fine sediment from the formation so, during sampling, water will not be turbid or contain suspended materials that can interfere with chemical analysis.

Shallow wells are generally developed with a bailer, a foot-valve pump, or a submersible pump. Pumping is usually a more efficient method for deeper wells. The selection of the well development methods and equipment will be determined on site by the field personnel based on drilling, well construction, and site-specific geologic information.

Well development will occur after a minimum of 24 hours following construction or after recovery is complete, whichever is later. All equipment that is introduced into the well will be decontaminated according to the procedures discussed in Section 4.4. The general procedures for well development are summarized below:

1. Measure the water level in the well with a water level indicator. The depth to the bottom of the well is measured with a weighted measuring tape.
2. A bailer or other pumping device is lowered to the bottom of the well. The well is surged by the bailer or the pump to agitate and loosen fines in the well screen and sand pack.
3. Groundwater is bailed or pumped from the well. If a pump is used, the pump intake will be periodically placed at different depths throughout the well and within the screen interval during development.
4. Readings of pH, temperature, specific conductance, and turbidity will be collected after each well volume removed or at other intervals depending upon well output and other factors pertinent to sampling.
5. Well development will continue until the field measurements stabilize. Ideally, the well should be developed to 50 Nephelometric Turbidity Units (NTU), if possible. The goal of 50 NTUs may not be practical in formations which contain a lot of silt and clay in which case the well will be developed until the turbidity readings appear to have stabilized.
6. The development tools will be removed from the well and the water level and well bottom will be measured following development.
7. The well will be covered and locked.

8. Purged water will be containerized pending subsequent sampling and handled according to the procedures outlined in Section 4.4.4.
9. All pertinent field data will be recorded on a Field Data Sheet (see Section 4.10).

4.8 Groundwater Sampling

Groundwater samples are collected from monitoring wells for laboratory analysis. The specific number and location of samples, rationale, and parameters to be tested are discussed in the Work Plan. The equipment and general procedures normally utilized for groundwater sampling are presented below.

4.8.1 Groundwater Sampling Equipment

Monitoring wells will be purged using one of the following pieces of equipment:

- Lubricant-free stainless steel submersible pump with polyethylene or Teflon discharge tubing.
- Peristaltic pump equipped with dedicated polyethylene tubing with or without a foot valve.
- Dedicated Teflon bailer connected to new solid-braid nylon rope.
- Inertial lift pump with dedicated polyethylene valve and tubing.

Project-specific purging methods are outlined in the Work Plan. The selection of a purging method is determined based on the following information:

1) Well depth
2) Static water level
3) Hydraulic conductivity
4) Well diameter
5) Well location

4.8.2 Procedures for Collecting Groundwater Samples

4.8.2.1 Pre-Sampling Activities

Before sampling, the following pre-sampling activities will occur:

- The well will be inspected for integrity and proper identification.
- A sheet of polyethylene will be laid out for placement of monitoring and sampling equipment.
- If site conditions are unknown, conditions warrant, or project requirements call for VOC monitoring, VOCs will be measured at the rim of the opened well with a PID and recorded in the field logbook.
- After removing the well cap, the water level will be allowed to equilibrate for a minimum of 5 minutes. The static water level in the well will be measured with a water level indicator to the nearest 0.01 feet referenced to a permanent mark on the PVC riser. The probe of the meter will be decontaminated according to the procedures detailed in Section 4.4.
- The volume of water in the well will calculated by the following equation:

$$V = (\pi) r^2 l (7.48)$$

where,
V = volume, in gallons
π = 3.14
r = inside radius of well, in feet
l = height of water in well, in feet
7.48 = conversion factor for cubic feet to gallons

- If present, the depth of any non-aqueous phase liquids (NAPLs) will be measured using an interface probe and recorded. If LNAPLs or DNAPLs are detected, the well will not be sampled. A sample of the LNAPLs or DNAPLs present may be obtained using a bailer, if appropriate.

4.8.2.2 Sampling Procedures

Low Flow Sampling:

- Install Pump: Slowly lower the pump, safety cable and tubing into the well to the depth specified for that well. The pump intake should be in the middle or slightly above the middle of the screened interval. Too close to the bottom increases the possibility that solids that have collected in the well over time will be collected in the sample. Too close to the top increases the possibility that water stored in the casing will be included in the sample. Record the depth to which the pump is lowered.

- Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

- Purge Well: Start pumping the well at 100 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every 5 minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should be reduced, if needed, to the minimum capabilities of the pump to ensure stabilization of the water level. Care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

- Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (temperature, specific conductance, and pH) approximately every 5 minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:

  ±0.1 for pH

  ±3% for temperature

  ±3% for specific conductance (conductivity)

The pump must not be removed from the well between purging and sampling.

- Sample collection should be directly from the dedicated or disposable tubing, not from the flow-through cell discharge hose.

- Remove pump and tubing: After collecting the samples, the tubing must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

- Close and lock the well.

Sample Collection
All laboratory samples will be placed in containers according to the procedures outlined in Section 4.3.3 of this document. Drums containing purge water will be handled in accordance with Section 4.4.4.

4.9 Water Level Measurements

Groundwater level measurements are taken to calculate groundwater elevations so that groundwater contour maps can be constructed. Groundwater contour maps are used to assess flow directions and hydraulic gradients.

Water levels are measured with a water level indicator to the nearest hundredth (0.01) foot. Measurements collected from monitoring wells are taken from the top of well casing. The measurement point is notched or marked indelibly on the casing.

Water levels are measured according to the following procedures:

- Check the well for proper identification.
- Inspect the integrity of the protective casing and surface seal.
- If previous data warrant, or unknown conditions exist, then monitor the ambient air in the breathing zone and at the well head while unlocking and removing the well cover.
- Using a pre-cleaned water level indicator, measure the water level to the nearest hundredth (0.01) foot from the reference mark at the top of the well riser pipe.
- Record the water level measurements in a field notebook and/or on a field data sheet along with the date and time of measurement.
- Decontaminate the water level probe between locations by rinsing it with methanol and deionized water.
- Replace the well cover and lock.

4.10 Ground Penetrating Radar

Ground penetrating radar (GPR) uses high frequency radio waves to investigate shallow geologic features (e.g. depth to the water table or depth to bedrock) and for the detection of buried objects. GPR can provide subsurface information ranging in depth from several tens of feet to inches and is useful for locating subsurface objects, utilities, and geologic interfaces.

Ground penetrating radar operates by transmitting pulses of microwave-range (0.1- to 100-cm

wavelength) electromagnetic energy into the ground through an antenna (a.k.a. transducer). Some of the energy is scattered where materials with different dielectric permitivity interface. The rest of the energy passes through the interface and on to the next interface where it may be reflected or pass through to deeper interfaces. The reflected signals are received by a control unit which registers the reflections against two-way travel time in nanoseconds. The control unit typically contains an output display on which the signals are plotted in profile (radargram).

The GPR antenna is pulled slowly along the ground surface radiating energy downward into the subsurface. Reflected energy is gathered at a receiving antenna and variations in the return signal are continuously recorded. These variations are caused by wave reflections from surfaces of materials having different electrical properties. These surfaces may be geologic features (e.g., soil interfaces, changes in moisture content, voids or fractures in bedrock) or indications of human activity (e.g., buried drums, utilities, tanks).

The depth of penetration is highly site-specific and is dependent on the soil types and properties. In general, dry, sandy soils provide better data, while moist, clayey or conductive soils provide poorer results.

4.10.1 Equipment/Instrumentation

The GPR system consists of a control unit, antenna, and a graphic recording device. The antenna transmits electromagnetic pulses of short duration into the ground. Pulses are reflected back to the antenna from the various interfaces within the subsurface. The receiver sends the signal to the control unit for processing and display.

Several manufacturers produce commercially-available GPR systems. For this reason, a detailed description of instrument operation is not practical. The operator should refer to the instrument setup and operations manual to prepare the instrument for a survey. The instrumentation should be selected based on the desired target and actual field conditions. The selection of a transducer frequency will need to balance the desired depth of penetration with resolution.

4.10.2 Field Procedures

The general field procedures for conducting GPR surveys are outlined below:

- Where possible, the instrument is calibrated by burying a metal object at known depth. The instrument is then adjusted so that the readings are consistent with the true depth.

- A grid of parallel lines is established across the investigation area. The size of the grid is dependent upon the project objectives and is detailed in the FSP.

- Data are collected by slowly pulling the antenna along the survey lines. The beginning and end points of each traverse should be surveyed from a known location, which can be recovered at a future date.

4.10.3 Data Analysis

Most modern GPR systems utilize portable digital processors operating on battery (DC) power. Digital processing allows the operator to utilize filtering, stacking, and gain controls as well as manipulate them in the field. Data is typically stored in an unfiltered (raw) form that can be reviewed and processed after the survey is complete.

GPR data are evaluated qualitatively in the field as the survey progresses. Data is displayed on the GPR system and observed in profile as it is collected. Estimates of depth are automatically made by utilizing a velocity conversion factor. The velocity conversion factor is a user-entered estimate of the radar wave propagation rate through the subsurface. It is used to determine distance (depth) from the GPR antenna.

4.10.4 Data Evaluation

The propagation velocity of the EM pulse depends upon the relative dielectric permittivity of the material (e_r) through which the pulse travels. The relative dielectric permittivity is a measure of the degree to which a medium can resist the flow of the EM pulse: the higher the relative permittivity, the lower the resistance to flow, and vice versa. For most earth materials and rocks, the relative dielectric permittivity does not exceed 10 and is always greater than unity, the value for a vacuum. The table below gives typical permittivity values for commonly encountered materials.

Approximate Electromagnetic Properties of Various Materials

Material	*Relative Dielectric Permittivity*	*Pulse Velocity (ns/ft)*
Air	1	1
Freshwater	81	9
Seawater	81	9
Sand (dry)	4 – 6	2.1 – 2.4
Sand (saturated)	30	5.5
Silt (saturated)	10	3.1
Clay (saturated)	8 – 12	2.8 – 3.3
Average “dirt”	16	4
Dry sandy coastal land	10	3.1
Marshy forested flat land	12	3.5
Rich agricultural land	15	3.9
Pastoral land, hilly, forested	13	3.6
Freshwater ice	4	2
Permafrost	4 – 8	2.0 – 2.9
Granite (dry)	5	2.2
Limestone	7 – 9	2.6
Concrete	6.4	2.5
Asphalt	3 – 5	1.7 – 2.5

The dielectric permittivity is related to the propagation velocity by the formula:

$$e_r = \left(\frac{c}{V_m} \right)^2$$

where, "c" is the propagation velocity in free space ($3x10^8$ meters per second or approximately 1 foot per nanosecond) and Vm is the propagation velocity through a material. It follows that

$$(e_r)^{1/2} = \frac{c}{V_m} \qquad \text{or} \qquad \frac{1}{V_m} = \frac{(e_r)^2}{c}$$

Since c is approximately equal to 1 ft/ns, then

$$1/V_m \approx (e_r)^{1/2} \qquad \text{(Formula 1)}$$

Where units are in ns/ft (one-way travel time).

Formula 1 gives a method for estimating the propagation velocity for a medium (and therefore the depth to a reflecting horizon) if the soil conditions are known. If they are unknown or their properties cannot be estimated accurately enough, a reflector of known depth can often be used to calibrate the GPR recordings to site conditions.

Approximate Depth Ranges for Various Antenna Frequencies

Frequency (MHz)	Minimum Target Size (m)	Approximate depth range (m)
100	0.1-1	2-15
250	0.05-0.5	1-10
500	0.04	1-5
800	0.02	0.4-2

4.11 Soil Vapor Sampling

If needed, soil vapor sampling will be conducted in accordance with the NYSDOH Guidance for Evaluating Soil Vapor Intrusion, Final October 2006.

Soil vapor samples are collected outside, and not beneath the foundation or slab of a building, to determine whether there is soil vapor contamination, to characterize the nature and extent of soil contamination, and to identify possible sources of contamination. The results are often used to evaluate the potential for current and future human exposures and to determine the effectiveness of measures implemented to remediate contaminated subsurface vapors.

4.11.1 Investigation Considerations

Existing environmental data and site background information are used to select the sample locations. When evaluating sites that are proposed for development, where soils are suspected or known to be contaminated, the soil vapor samples should be collected from:

- Known or suspected VOC source material
- In a grid pattern across the area
- From multiple depths from suspected subsurface sources, former source, or a depth comparable to the expected depth of foundation footings.

Soil vapor intrusion investigations often involve more than one round of sampling.

4.11.2 Sample Probe Installation

Samples at depths less than 5 feet below the ground surface (bgs) are prone to negative bias from infiltration of outdoor air and should only be collected when deeper samples are not feasible.

Soil vapor probe installation can be permanent, semi-permanent, or temporary. Permanent probes are preferred for data consistency. Soil probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be used when constructing and installing soil probes:

- Direct-push technology is the preferred method of installing sample probes. When necessary, an auger could be used.
- Porous backfill material (e.g. coarse sand or glass beads) should be used to create a sampling zone of 1 to 2 feet in thickness.
- Implants/probes should be fitted with VOC-inert tubing (e.g. polyethylene, stainless steel, or Teflon®) of the appropriate size (typically $^{1}/_{8}$-inch to $^{1}/_{4}$-inch diameter) that is of laboratory or food grade quality.
- The probes should be sealed above the sampling zone with bentonite slurry for a minimum depth of 3 feet to prevent surface air infiltration. The hole should be filled with clean material.
- For multiple probe depths, the borehole should be grouted with bentonite between probes to create discrete sampling zones.
- For permanent installations, a protective casing should be set around the top of the probe tubing and grouted in place to the top of the bentonite to minimize infiltration of outdoor air, as well as to prevent accidental damage to the probe.

4.11.3 Soil Vapor Sample Collection

Soil vapor samples should be collected in the same manner at all locations to minimize discrepancy and should include the following:

- Samples should be collected a minimum of 24 hours after the installation of permanent probes, and shortly after the installation of temporary probes.

- One to three implant volumes (volume of sample probe and tube) must be purged prior to sample collection.
- Flow rates for purging and collecting must NOT exceed 0.2 liters/minute to minimize outdoor air infiltration.
- Use conventional sampling methods, in an appropriate container that meets the requirements of the sampling and analytical methods and has been certified to be clean by the laboratory.
- Sample size is dependent on the volume needed for laboratory minimum reporting limits.
- Tracer gas (i.e. helium, butane, or sulfur hexafluoride) must be used to verify that outdoor air infiltration is not occurring. Once verified, continued use of the tracer gas may not be necessary. Two approaches can be selected when using a tracer gas:
    - Include the tracer gas in the list of laboratory analytes.
    - Use a portable field monitoring device to analyze the sample for the tracer gas.

4.11.4 Documentation/Considerations

The following should be considered during a soil vapor sampling event and may influence the interpretation of the results:

- If sampling near a building, uses of VOC-containing products during normal operations of the facility should be identified.
- Outdoor sketches, including site, streets, nearby facilities, and outdoor ambient air sample locations (if appropriate) should be drawn.
- Weather conditions should be noted for 24-48 hours prior to sampling events.
- Pertinent observations (odors, field screening readings) should be recorded.

A sample log sheet should be maintained to include:

- Sample ID
- Sample date and time
- Sampler ID
- Sampling Methods/devices
- Purge volume
- Volume of vapor sample
- For canisters, the vacuum reading before and after sample collection
- Apparent moisture content of sampling zone
- Chain of Custody procedures used to track sample

4.11.5 QA/QC Precautions and Laboratory Analytical Methods

On the day of sample collection activities, the person collecting the samples should avoid the following: fueling vehicles, use of permanent markers, wearing freshly dry-cleaned clothing, wearing perfumes, and any other activity where the use of VOCs could contaminate the samples. Proposed analytical procedures are identified in the Work Plan. TO-15 for VOCs, and NYSDOH Method 311-9 for tetrachloroethene are the preferred laboratory analytical methods.

5.0 DOCUMENTATION / CHAIN OF CUSTODY PROCEDURES

5.1 Chain of Custody

Chain-of-Custody (COC) procedures are followed to insure that sample integrity is maintained throughout the sampling and analysis process and that all samples collected are accounted for at all times. The COC process begins when the sample is collected and carries on throughout the analytical laboratory operations. The field team member responsible for the collection of the samples acts as the initial sample custodian.

A sample is considered "in custody" of an individual if it is either in direct view of, or directly controlled by, that individual. Chain-of-Custody transfer is accomplished when the samples or sealed sample containers are directly transferred from one individual to the next. At the time of transfer, the first individual witnesses the signature of the receiver on the COC record. The objective of the COC program is to ensure that:

- Samples are protected from loss or damage.
- The correct samples are analyzed.
- All samples are uniquely identified.
- Samples are traceable to their records.
- Documentation of sample handling procedures including: sample location, sample number, number of sample containers, and the COC process.
- A signed COC record is included for each sample shipment, documenting contents of the shipment. The COC record indicates the following information:
  - Site name
  - Sample Identification Numbers
  - Date and time of collection
  - Sample type (e.g., groundwater, soil, etc.)
  - Number and type of containers per sampling location
  - Parameters requested for analysis for each container
  - Signature of person(s) involved in the chain-of-possession
  - Description of sample bottles and their condition
  - Problems associated with sample collection (i.e., breakage, no preservatives), if any.

The COC records are printed on triplicate forms. One copy is retained by The Chazen Companies when the samples are taken into custody by either a shipping agency or the lab. A second copy is kept by the analytical lab. The third copy is returned to Chazen with completed lab results.

5.1.1 Sample Tracking

In order to track the samples sent to the laboratory, a permanent log of each shipment is maintained in a log book. A copy of all COC records is also maintained in a project file. All pertinent COC information is recorded in the log book, as well as follow-up correspondence with the laboratory, via telephone or mail, indicating receipt of the samples, breakage, turnaround

time, or any problems with the shipment. As analytical data are received, the database is updated to reflect the new information. Turnaround times are compared to protocols to ensure quality control. Missing data or invalid samples are addressed by the Field Operations Leader or the Project Manager.

5.1.2 Laboratory Operations

Specific laboratory Standard Operating Procedures used during the investigation are provided by the selected analytical laboratory. These procedures include sample tracking, methods for collection and handling of laboratory blanks, laboratory duplicates, matrix spikes, laboratory control samples, and surrogates. Maximum/minimum holding times and data reporting procedures are also defined by the laboratory.

5.2 Analytical Sample Shipping

Sample containers are packed in coolers. Bottles are packed tightly in materials such as Styrofoam, vermiculite, and/or "bubble pack" to minimize motion. Ice is placed in zip-lock bags and can be added to the cooler to cool the samples to around 4° C. All paperwork is sealed in a separate zip-lock bag and placed in the cooler which is then taped shut. The samples are shipped to the laboratory together with the COC documents.

The standard procedure followed for shipping environmental samples to the analytical laboratory is:

1) Samples are shipped by courier or equivalent overnight delivery service.
2) Samples are shipped to the laboratory within 24 to 48 hours of acquisition.
3) Prior to leaving for the field, the Analytical Lab is notified of the number, type, collection date, and shipment dates for samples. If the number, type, or date of shipment changes due to site constraints or program changes, the Lab is informed of the change. Notification to the Lab also occurs when sample shipments will arrive on Saturdays. This communication is critical to allow the laboratory enough time to prepare for the samples' arrival.
4) If prompt shipping and laboratory receipt of the samples is not possible, members of the Field Team are responsible for proper storage of the samples until adequate transportation arrangements can be made.

6.0 CALIBRATION PROCEDURES

This section details the calibration and operating procedures for the field and laboratory analytical instruments that will be used during this investigation.

6.1 Field Instruments

Field instrumentation is calibrated according to the manufacturer's instructions to ensure that accurate field data are collected. Each piece of equipment is calibrated daily prior to use or as specified by the manufacturer. More frequent calibration may be performed when accuracy of the equipment becomes suspect or under extreme field conditions. Calibration information is recorded in the same field notebook in which the field instrument readings will be recorded. The recorded calibration includes:

- Name of instrument
- Instrument serial number
- Date of calibration
- Observations and results of calibration
- Calibration gas used, if applicable
- Buffer solutions used, if applicable
- Specific calibration procedures and operating instructions are detailed below.

6.1.1 pH Meters

pH is the measure of the acidity or alkalinity of a solution. It is defined as the negative logarithm of the hydrogen ion activity. Hydrogen ion activity is related to the hydrogen ion concentrations, which in relatively weak solutions are nearly equal. For practical purposes, pH is the measure of the hydrogen ion concentration.

The operation of a pH meter relies on the same principal as many other ion-specific electrodes. Measurement relies on establishment of a potential difference in the response to hydrogen ion concentration across a membrane in the electrode. The membrane is conductive to ionic concentrations, which in combination with a reference electrode (which can be combined into a single "combination" electrode), can generate a potential difference proportional to the hydrogen ion concentration.

Variation in temperature will effect the association of hydrogen and hydroxide ions, which without proper compensation will affect the pH. pH meters have several controls to compensate for the variations between electrodes and the different responses to changes in temperature.

It is very important to obtain a pH measurement as soon as possible after sample collection, since temperature changes, precipitation/dissolution reactions, and sorption of carbon dioxide from the air all affect the pH of a solution.

Because of the great variety of pH meters available, operators should refer to the manufacturer's instruction manual for specific calibration, operation, and troubleshooting procedures for their instrument. The following general procedure is used for measuring pH in the field with a pH meter:

- The pH meter is calibrated at each sample site.
- The instrument and batteries are checked prior to the initiation of the field effort. pH electrodes are kept moist at all times.
- Buffer solutions used for calibration are checked since buffer solutions will degrade upon exposure to the atmosphere.
- Generally, 4.00 and 7.00 pH buffers are selected for calibration.
- All electrolyte solutions within the electrode(s) are filled to their proper levels and no air bubbles are present within the electrode(s).
- The electrodes are immersed in a pH-7 buffer solution.
- The temperature compensator is adjusted to the proper temperature (on models with automatic temperature adjustments, immerse the temperature probe into the buffer solution). Alternatively, the buffer solution may be immersed in the sample and allowed to reach temperature equilibrium before equipment calibration. It is best to maintain buffer solution at or near expected sample temperature before calibration.
- The pH meter is adjusted to read 7.0.
- The electrodes are removed from the buffer and rinsed well with deionized water. The electrodes are immersed in pH-4 (or pH-10 buffer solution) and the slope control is adjusted to read the appropriate pH. To check the calibration, three successive readings are taken, one minute apart, to see that readings are within ±0.1 pH unit.
- The electrodes are immersed in the unknown sample, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.
- The pH and temperature of the sample are read and recorded. pH is recorded to the nearest 0.1 pH unit.
- The electrodes are rinsed with deionized water.

6.1.2 Specific Conductance Meters

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of ionized substances dissolved in the water and the temperature at which the measurement is made. It is important to obtain a specific conductance measurement soon after sample collection since temperature changes, precipitation reactions, and sorption of carbon dioxide from the air affect the specific conductance.

Specific conductance can be used to identify the direction and extent of the migration of contaminants in groundwater and surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

Because many conductivity meters are available, operators should refer to the manufacturer's instruction manual for specific calibration, operation, and troubleshooting procedures. The following general procedure is used for obtaining specific conductance measurements:

- The conductivity meter is calibrated at the start of each sampling day or more frequently if deemed necessary.
- Batteries are checked before going into the field.
- The instrument is calibrated using a potassium chloride standard solution by completely immersing the electrode into the solution. The temperature of the calibration solution is checked and the temperature dial is adjusted on the meter (if not self-compensating). Calibration measurements and time are recorded in the field logbook.
- The umho value of the solution is checked in terms of the temperature. The Cell Constants dial is adjusted until the display reads the appropriate value.
- The electrode is rinsed with one or more portions of the sample to be tested.
- The electrode is immersed in the sample and the temperature and the conductivity are measured.
- The results are noted in the field logbook.
- If the specific conductance measurements become erratic, or inspection shows that any platinum black has flaked off the electrode, replatinization of the electrode is necessary. See the manufacturer's instructions for details.

6.1.3 Photoionization Detector

For monitoring total ambient air quality during field activities and for conducting static headspace testing, TCC uses a MiniRae 2000 PID. This instrument measures total VOC concentrations. The operating and calibrating procedures for this instrument follow.

A MiniRAE 2000 PID can be used to detect a variety of trace gases, particularly VOCs. The MiniRAE 2000 uses the principle of photoionization to detect and measure the VOC concentrations in the atmosphere or from a sample.

The MiniRAE 2000 operates using an electrodeless discharge ultraviolet (UV) lamp as the high-energy photon source. As organic vapors pass by the lamp, they are photo-ionized and the ejected electrons are detected as a current. The PID sensor with a standard 10.6 eV lamp detects a broad range of organic vapors. In principle, any compound with ionization energy lower than that of the lamp can be measured.

The following procedure is used for operating and calibrating the MiniRAE 2000:

- Press and hold the MODE key for one second and release to turn on the MiniRAE 2000. The audio buzzer will beep once and the air pump will turn on. The display will show "ON"
- To turn off the MiniRAE 2000, press and hold the MODE key for 5 seconds. The monitor will beep once per second during the power-down and the message "OFF" will flash and the screen will go blank.
- After the monitor is turned on, it runs through the start up menu and then a "READY…" message is displayed. At this point the user can either 1) step through the operation menu or 2) take a measurement.
- In the first menu of the programming mode, the user can calibrate the MiniRAE 2000. The calibration is a two-point process using "fresh air" and the calibration gas (Isobutylene)
- Calibration Process
  - Press and hold down both the [N/-] and MODE keys for three seconds to enter the programming mode; the first menu item is "Calibrate/select Gas"
  - The Fresh Air calibration determines the zero point of the sensor calibration curve. If a fresh air source from a cylinder or tedlar bag is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.
  - The first menu shows "Fresh Air Cal?"; make sure the instrument is connected to the fresh air source; press the [Y/+] key, the display will show "zero in progress", flowed by "wait.." and a countdown timer; after a pause, the display will show the message "zeroed…reading= x.x. ppm…"; press any key or wait about 20 seconds, the monitor will return back to the submenu.
  - For the second point of the sensor calibration, a cylinder of span gas (Isobutylene) fitted with a 500 cc/min. flow limiting regulator is attached to the instrument.
  - Press the [Y/+] key at the "Span Cal?" to stat the calibration. The display shows the gas name and the span value of the corresponding gas; the display will show "Apply gas now" at which point the valve will be turned to open the gas supply.
  - The display with ask you to wait 30 seconds. When the count down timer reaches 0, the display will show the calibrated value. Turn off the flow to gas and disconnect the span gas. Press any key
- To record measurements
  - Press the [Y/+] key to start a measurement in survey mode
  - Instantaneous readings in ppm are updated every second
  - To stop measurements press the MODE key and the display shows STOP. Press [N/-] to continue measurement

The meter is calibrated once per day or more frequently, if necessary. The MiniRAE 2000 is used to monitor the breathing zone for health and safety precautions or to screen samples by placing the probe near suspected sources of contaminants.

6.1.4 Airborne Particulate Matter Meters

For monitoring airborne particulate matter (i.e., dust) during field activities, TCC uses a MIE, Inc. Personal Data-logging Real-time Aerosol Monitor (*personal*DataRAM). This instrument provides direct and continuous data measurements and is a high sensitivity nephelometric monitor optimized for the measurement of the respirable fraction of airborne dust emitted from

ground intrusive work or work that has the potential to produce dust. The following procedures are used for calibrating and operating the *personal*DataRAM:

- Calibration/Zeroing Process
  - Conduct zeroing in a particle-free environment such as a *personal*DataRAM Z-Pouch, a clean room, a duct or area directly downstream of a HEPA filter, or the MINIRAM Z-Bag. The following instructions are for the Z-Pouch.
  - Wipe the outside surfaces of the instrument to remove as much dust as possible, then in a reasonably clean area, open the zipper of the Z-Pouch and place the unit inside.
  - Open the small nipple of the Z-Pouch and insert the fitting of the hand-pump/in-line filter unit into the nipple. Start pumping the hand-pump until the Z-Pouch begins to bulge slightly.
  - While continuing to pump, press ENTER and keep pumping slowly while ZEROING is displayed for 1.1 minutes followed by CALIBRATION: OK. If screen shows BACKGROUND HIGH or MALFUNCTION, consult instruction manual.
  - To set up a run and scroll logging/operating parameters, press NEXT when screen shows READY: NEXT.
  - After completing zeroing process, remove the *personal*DataRAM from the Z-Pouch, close the zipper and flatten the Z-Pouch while plugging its nipple to prevent dust contamination in the Z-Pouch.

- Operating Process
  - To enable the logging function, press ENTER when screen shows LOGGING DISABLED.
  - LOG INTRVL 600s indicates that logging is enabled (in this example for 10-minute log period). Press ENTER.
  - At ALARM: OFF press ENTER to toggle through alarm modes.
  - Press NEXT to move through the calibration factor screen and battery charge screen.
  - Press NEXT at CONNECT TO PC, then again to return to ready mode (this will enable data to be downloaded).
  - Press ENTER at LOG INTRVL with TAG # displayed. Concentration screen will be displayed after three seconds. Pressing NEXT will successively scroll to show various run values.
  - Press EXIT to terminate the current run, then ENTER to return to Ready mode.

6.1.5 Gas Chromatograph

GC calibration is generally conducted prior to mobilization to the site as it can take several hours to complete. This effort involves creating a calibration curve constructed by injecting the same volume of several standards with varying concentration levels of the target compounds.

Serial Dilution of Certified Calibration Standards

Certified standards of target compounds can be purchased from various laboratory supply companies. Purchased standards are typically 1,000 ug/L or 2,000 ug/L in concentration. Using them directly at this concentration may lead to fouling of the GC column. Only diluted standards

are used for calibration. The following procedure can be used to serially dilute the certified standard to lower concentrations:

1. Using a clean syringe, add 1 ml of 1,000ug/L standard to 9ml purge and trap grade methanol to create a 100ug/L standard.
    a. If mixing two or more single compound standards together, use 1 ml of each and add sufficient methanol to make a total of 10ml of solution.
2. Repeat the process with the newly created 100ug/L standard to create a 10ug/L standard.
    a. Note that compounds are not added individually at this point.
3. Repeat the process a third time to create 1ug/L standard.

Creating a Calibration Curve

Certified standards are provided with a chromatograph from the manufacturer. If the standard contains more than one compound, the order of elution can be gleaned from the chromatograph. For custom mixtures of standards created for the field, a check of readily available references will provide the elution order. The following procedure is used to create a calibration curve for the SRI GC utilizing Peak Simple software from SRI.

1. Using a syringe, introduce 1uL of a prepared standard onto the column while simultaneously starting the data recorder on the PC.
2. Allow the GC to run through the pre-programmed temperature and pressure programs until the final compound has completely eluted.
3. Record the calculated area under each peak into the calibration table for each compound in Peak Simple. Peak Simple will automatically create an average of analytical runs if the same standard is analyzed more than once.
4. In Peak Simple, select the best fit algorithm for matching a line to the area vs. concentration results.
   Once the area and concentration data have been entered into the tables and lines have been fitted to the resultant chart, Peak Simple will calculate a concentration for each compound that peaks within the windows of time that the known standards are anticipated to elute during subsequent analytical runs.

6.2 Laboratory Equipment Calibration

The Laboratory's Project Manager will be responsible for the operation and calibration of laboratory analytical instruments in accordance with the schedules and procedures specified by the NYSDEC ASP (Analytical Services Protocol, Revised September 1993).

The laboratory calibration procedures are addressed in the QA documents for the laboratory subcontractor.

7.0 ANALYTICAL PROCEDURES

Laboratory analyses will be scheduled based on previous site investigation information, review of data objectives, and NYSDEC criteria. Specific parameters are outlined in the Field Sampling Plan.

7.1 Analytical Laboratory

All sample analyses will be performed by a laboratory certified by the New York State Department of Health (NYSDOH). In order to provide legally defensible data, selected analytical procedures to be used will be in accordance with the most recent NYSDEC ASP. Laboratory analytical parameters will be based on previous site information, as well as data quality objectives and applicable NYSDEC criteria. The sampling program and related analytical methods are documented in the FSP. All samples will be received by the laboratory within 48 hours of collection.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Independent third party data validation will be utilized. Data will be validated using the NYSDEC ASP Revision 12/91 and the USEPA Region II Functional Guidelines. The details supporting an independent validator's selection, describing how the individual is independent from the project, will be set forth in the Work Plan or other supplementary documentation.

8.1 Data Reduction

Data reduction is the conversion of raw data into a useful form from which conclusions can be made and presented. Raw data may consist of field data, which are real-time measurements, and technical data, which includes field and laboratory analytical data. Raw field data (e.g. PID readings) will be compared to laboratory analytical results which will be compared to site-specific criteria.

8.2 Data Validation

Data validation is the process of reviewing data and accepting it or rejecting it on the basis of sound criteria.

Records of all data will be maintained, even those judged to be "outlying" or spurious values.

The principle criteria that will be used to validate the integrity of the data during collection and reporting should be modeled from the following EPA guidance documents:

- "National Functional Guidelines for Organics Review", (USEPA, June, 1991)
- "Laboratory Data Validation, Functional Guidelines for Evaluating Inorganic Analyses", (USEPA, October, 1989)
- "NYSDEC ASP Revision 12/91"

8.2.1 Field Data Validation

Field data will be validated at the time of collection by following standard procedures and QC checks and after the data is reduced to review data sets for anomalous values. The objectives of field data validation are as follows:

- Adherence to approved site-specific plans.
- Standard operating procedures are followed.
- Sufficient sample volume is obtained, sample integrity is maintained, all required analyses are conducted, and all applicable field QC samples are provided with each sample set.
- Complete chain-of-custody documentation is maintained throughout the duration of the field effort.
- Maximize data consistency between field personnel by random checks of sampling and field conditions by supervisory personnel.

8.2.2 Laboratory Data Validation

Laboratory data verification will be performed by qualified individuals appointed by the analytical laboratory. Data verification will involve routine audits of the data collection and flow procedures and monitoring GC sample results. Results from the analysis of project and blind audit QC samples will be calculated and evaluated as reported. Immediate corrective action will be taken if these results indicate data quality problems.

An individual independent from the project will be responsible for validating the laboratory data, in some cases. Details supporting the validator's selection, describing how the individual is technically qualified to do the validation and independent from the project, will be presented in the Work Plan. Independent validation will be according to criteria such as:

- Holding times
- Instrument tuning and performance
- Calibration
- Blanks
- Surrogate recoveries
- Matrix spike and matrix spike duplicate recoveries

8.3 Reporting

When required for a project, Category B Deliverables will be supplied for laboratory analysis. Validated field and laboratory data will be presented in a final report in the form of tables and/or figures. Figures may include planimetric maps, cross sections, and contour maps. All supporting data, such as raw field and laboratory analytical data, will be presented as an appendix to the final report. Electronic files may be provided in lieu of hardcopies.

9.0 INTERNAL QUALITY CONTROL PROCEDURES

Quality control (QC) checks will be performed to ensure the collection of representative and valid data. QC checks provide the mechanisms by which the quality assurance objectives are monitored.

9.1 Field Quality Control

Field quality control measures will be conducted in accordance with the NYSDEC RCRA Quality Assurance Project Plan Guidance dated March 29, 1991. The field QC checks that will be used are listed and described as follows.

9.1.1 Documentation

All activities must be properly documented including: sampling procedures, decontamination activities, chain-of-custody procedures, equipment calibration, and justification for all actions taken contrary to the approved QAPP, Work Plan, and FSP.

9.1.2 Blank and Duplicate Samples

Three types of blanks can used during sampling: trip blanks, field blanks and equipment blanks. These are discussed below.

Trip Blanks: Trip blanks are for assessing the potential for contaminating aqueous samples with VOCs during sample shipment. The trip blank consists of a VOC sample container shipped to the site with the other VOC sample containers either filled with reagent water at the lab or filled on-site with reagent water. Trip blanks will be used so as to maintain a 1:20 ratio of blanks to samples or with each shipment, whichever is greater. Non-aqueous samples do not require trip blanks.

Field Duplicates (Replicates): When required, field duplicates of soil, sediment, and groundwater samples will be submitted for analysis of all site-specific parameters at a rate one every 20 samples collected for analyses. These duplicates are intended to assess the homogeneity of the sampled media and the precision of the sampling protocol. True duplicates of soil, sediment, and solid waste samples; however, are not possible because chemicals are typically not uniformly distributed.

Equipment Blanks: Equipment blanks for the bailer, sampling pump, and/or tubing assembly are collected during monitoring well sampling at a rate of one per day on one piece of equipment per equipment type. VOCs, SVOCs, or inorganics present within the bailer, pump apparatus, or discharge tubing are assessed by collecting a sample of reagent water passed through the sampling apparatus after washing with the decontamination solution followed by at least one rinse with reagent water.

Equipment blanks, sometimes called rinsate blanks, are collected during each field event at a rate of one per day on one piece of equipment per equipment type. VOC, SVOC, or inorganics present within or on the sampling apparatus where intimate contact with the sample occurs (i.e.,

split-spoon, trowel) are assessed by rinsing the sampling apparatus with ASTM Type II water following decontamination. Rinsate blanks are collected directly into the appropriate water container.

Matrix Spike/Matrix Spike Duplicates (MS/MSD): For some projects, the NYSDEC ASP requires the laboratory to analyze MS/MSDs for organic analyses at a frequency of five percent. To meet this requirement, the Field Operations Leader will select samples for MS/MSD analyses and will provide additional sample volume to the laboratory.

9.1.3 Completeness

Completeness of scheduled sample collection is controlled in the field by comparing a pre-sampling inventory with samples actually collected each day. Daily checking of field data sheets and comparison of transport and COC logs provides further control of documentation and completeness.

9.1.4 Field Analytical Quality Control

QC checks are performed on field measurement systems that emulate laboratory measurement systems (e.g., portable field GC).

9.2 Laboratory Analytical Quality Control

Data from QC samples (e.g., blanks, spiked samples) will be used as a measure of performance and as an indicator of potential sources of cross-contamination. In some cases, quality control data and records will be submitted to the data validator. Laboratory analytical quality control will be in accordance with the requirements outlined in the NYSDEC RCRA Quality Assurance Project Plan.

10.0 PERFORMANCE AND SYSTEM AUDITS

10.1 Systems Audit

System audits are performed to ensure that the QA/QC procedures are being followed. These audits include a careful evaluation of both field and laboratory control procedures.

Organization and Personnel: The project organization is reviewed for compliance with the proposed organization and for clarity of assigned responsibility. Personnel assigned to the project will be placed so that responsibility, skill, and training of the personnel are properly matched.

Facilities and Equipment: The audit will address whether field equipment and analytical instruments are meeting requirements specified by the project objectives stated in the Work Plan. Equipment and facilities provided for personnel health and safety may also be evaluated. Calibration and documentation procedures for instruments will also be verified.

Analytical Methodology: A review of analytical methodology with regard to the data requirements for the project will be performed. An on-site observation of analyst technique, data reduction, and record keeping may be performed if determined necessary. Periodic review of precision and accuracy of data will be performed.

Sampling and Sample Handling Procedure: An audit of scheduled samples versus samples collected versus samples received for analysis may be performed. Field documentation may be reviewed. If deemed necessary, a site visit will be made to document that designated control procedures are practiced during sampling activities.

Data Handling: During a system audit, the Quality Assurance Manager will review data handling procedures with the TLs. Accuracy, consistency, documentation, and appropriate selection of methodologies will be discussed:

10.1.1 Field Systems Audit

Field systems audits are performed by QA personnel to compare field practices with standard procedures. These audits focus on such things as:

- Compliance with Work Plan
- Proper working order of field equipment
- Documentation procedures
- Field team efficiency
- Level of QA conducted by field members
- Proper sample packaging and shipping

10.1.2 Laboratory Systems Audit

Laboratory systems audits are conducted to ensure that measurement systems are properly maintained and used. Laboratory records and procedures may be reviewed for completeness, accuracy, precision, and adherence to prescribed methods.

10.1.3 Field Performance Audits

Field performance audits are conducted by QA personnel on an ongoing basis during a project as field data are generated, reduced, and analyzed. Field performance audits include review of numerical manipulations and review of blank and replicate samples.

10.1.4 Laboratory Performance Audits

Laboratory performance audits may be conducted and may include:

- Verification of written procedures, and analyst's understanding
- Verification and documentation of procedures and documents
- Periodic unannounced inspections, if warranted
- Review of a portion of all analytical data and calculations

11.0 PREVENTATIVE MAINTENANCE

11.1 Analytical Instrumentation

Preventative maintenance of analytical instrumentation is outlined in the QA documents of the subcontract analytical laboratory.

11.2 Field Instrumentation and Equipment

Preventative maintenance of field instrumentation and equipment includes the following measures:

- The field operations leader shall ensure that all scheduled maintenance occurs as obligated.
- Critical spare parts will be kept in stock.
- Equipment will be cleaned on a daily basis after use.
- Field crews will report on the condition and performance of the equipment after each sampling event.

12.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

The purpose of a data quality assessment is to document that data generated under the program are accurate and consistent with project objectives. The quality of data is assessed based on the precision, accuracy, representativeness, comparability, and completeness of the data that are generated. Data quality assessments are conducted in three phases.

Phase I: Prior to data collection, sampling, and analysis procedures are evaluated in regard to their ability to generate the appropriate, technically acceptable information required to achieve project objectives.

Phase II: During data collection, results will be assessed so that selected procedures are efficient and effective and that the data generated provide sufficient information to achieve project objectives. In general, evaluation of data are based on performance audits, results of duplicate and spiked sample analyses, and review of completeness objectives.

Documentation may include:

- Number and identity of duplicate samples collected
- Number and identity of duplicate, spike, and field blank samples analyzed
- Identification of statistical techniques, if used
- Use of historical data
- Identification of analytical method
- Data validation results

Procedures for assessing precision and accuracy for analytical data are outlined in Section 3.2. Precision is generally expressed as the relative percent difference (RPD) among duplicate analyses. Accuracy is generally expressed as percent recovery. Precision and accuracy of instrumental analysis is further addressed in the NYSDEC ASP and the Laboratory QAPP. It is the laboratory's responsibility to attempt to identify the source of substandard recoveries and take corrective action or document the cause as required by the NYSDEC ASP.

Phase III: Following completion of data collection activities, an assessment of the adequacy of the database generated in regard to completing project objectives is undertaken by the Project Manager and/or the Technical Reviewer. Recommendations for improved QC are developed, if appropriate. If data gaps are identified, additional raw data collection may be recommended to fully support the project findings and recommendations.

13.0 CORRECTIVE ACTIONS

Corrective actions are QA/QC problem-solving measures taken to rectify a laboratory or field measurement system that is out of control. Corrective action is required when potential or existing conditions are identified which may adversely affect the data quality. The need for corrective action may be identified by system or performance audits or by standard QC procedures. The corrective action system will include the following procedures:

The Project Manager is immediately notified of any potential problem with the data quality, and will then evaluate the need for changes in affected procedures and conduct appropriate corrective actions. Potential data quality problems may include:

- Loss of a sample or damaged sample containers.
- Analytical results that are substantially different from those expected.
- Laboratory QC samples that do not attain target performance objectives.
- Events that may require changes in specifications and sampling procedures.

Corrective action related to questionable analytical results or damaged sample containers may include re-sampling and re-analysis, if appropriate. Modification of procedures may be necessary to remedy problems related to unexpected conditions encountered in the field.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The Project Manager submits periodic QA reports for appraisal by management, appropriate to their level of responsibility. Reports to management include:

- Periodic assessment of measurement data accuracy, precision, and completeness.
- Results of performance and system audits.
- Significant QA/QC problems and recommended solutions.
- Resolutions of previously stated problems.

14.1 Field Quality Assurance Reports

Periodic status reports describing the progress of the project are submitted periodically to management. These reports include: copies of field notes or daily field progress reports, compiled field data sets, and corrective action documentation. The Project Manager is notified immediately of situations requiring corrective action measures.

14.2 Laboratory Quality Assurance Reports

A project QA report that summarizes QA activities and QC data is issued to the QA Manager and Project Manager. Any laboratory QA situations requiring immediate corrective action is reported to the Project Manager.

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Quality Assurance Project Plan
Attachments

Manufacturers of Petroleum & DNAPL Screening Kits

OIL-IN-SOIL™

Oil Screening Test Kit

Instruction Manual

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OIL IN SOIL, LLC
6 Queen Anne Road
Levittown, PA 19057 USA
Tel: (215) 687-0355
www.oil-in-soil.com

"Congratulations on purchasing the easiest and fastest test kit available today for screening hydrocarbons and DNAPL!"

INTRODUCTION:
The OIL-IN-SOIL™ screening kit is composed of a styrene bottle; a label indicating recommended soil and water levels; a small Styrofoam ball, and a cube containing finely dispersed dyes which is glued to the inside of the jar lid.

In the **Sudan IV** version of the screening test kit the cube is impregnated with two dyes:

- A deminimis amount of **SUDAN IV**, a Red Azo Dye soluble in most DNAPL and petroleum which stains the oils and petroleum products, and a
- Fluorescent Green/Yellow water soluble dye to color the water and provide a visual backdrop for the red dye.

The dual dye method is employed to improve detection by the user. The other soil test kits all contain the single dye indicated by the product name.

USING THE KIT:
OIL-IN-SOIL kits are designed with ease of use in mind. Simply follow the instructions on the label:

Step 1 Fill the bottle with soil to the line "*Fill soil to HERE*"
Note: Do not compact the soil.
Step 2 Fill the bottle to the line "*Fill water to HERE*" →
Note: ensure water is warm enough to dissolve the cube.
Step 3 Replace cap on bottle and shake jar until cube is **completely** dissolved.

If DNAPL or petroleum is present in the sample a red meniscus (or red spots on the side of the jar) will appear within 30-60 seconds. If color is not immediately apparent in the jar – check the polystyrene ball. The presence of ANY color on the ball (even a faint pink halo or hue) indicates the presence ore more than 500ppm TPH in that sample material. Conversely, a "clean" ball indicates that there is less than 500ppm TPH.

Note: Most DNAPLs dissolve styrene. Therefore, red spots may appear on the sides of the jar.

Note: Whenever possible, use potable water for the screening tests. However, salt water can be used if necessary.

Cold water can inhibit the rapid release of viscous hydrocarbons from soil and cause False Negative results. Therefore, at temperatures below 68º F (20º C), we recommend users carry a thermos of hot water for field testing purposes.

RECOMMENDED PROTECTIVE EQUIPMENT:

Please follow safety instructions outlined in the MSDS. Always use gloves and safety glasses when using the OIL-IN-SOIL™ kits.

DISPOSAL OF USED KITS:
As per the MSDS and local regulations.

MANUFACTURER'S GUARANTEE:

We will replace any broken or defective kits purchased.

If you are not satisfied with our product, return any defective kits to OIL-IN-SOIL for a refund. We reserve the right not to provide refunds if the kits have been tampered with in any way, or if not used in accordance the OIL-IN-SOIL MSDS and Instruction Manual.

OIL IN SOIL, LLC
Levittown, Pennsylvania
USA

info@oil-in-soil.com

Material Safety Data Sheet
To comply with OSHA's Hazard Communication Standard, 29 CFR 1910.120

OIL-IN-SOIL Test Kit
CAS 3 85-83-6 (SUDAN IV; OIL REB"B")

SECTION I – Manufacturer and International Distributors

Manufacturer:
OIL IN SOIL, LLC
6 Queen Anne Road
Levittown, PA USA 19057
1 (215) 687-0355
info@oil-in-soil.com

All Products are produced in and shipped from Pennsylvania USA
Date of MSDS Preparation 6/7/96

SECTION II --Composition Information on Ingredients
Dyes are dispersed in a sugar cube that has an approximate weight of 2.4 g. The red dye, is a standard dye used throughout the oil industry to color the oil red, is a possible mutagen but its weight is less than 0.1 percent. The fluorescent green dye comprises less than 1 percent of the weight of the dye cube and is not hazardous.

SECTION III -- Physical Characteristics
Property
Melting point - 186 ^{o}C
Specific gravity - 1.58

Solubility in water -sugar cube - very soluble
(water soluble dye - very soluble)
(red oil dye - insoluble in water soluble in oil or other hydrocarbons)

Flammability limit - Unknown
Extinguishing media - Water or foam
Special Fire Fighting Procedures - None

SECTION IV -- Reactivity Data
Stability - All Components are STABLE.
Incompatibility - None
Hazardous decomposition production - Stable compounds
Hazardous Polymerization - Will not occur
Conditions to Avoid - Fire

SECTION V -- Health Hazard Information
First Aid
If swallowed wash out mouth. If dye comes in contact with skin thoroughly wash area with soap and water.
Eye Contact
Flush eyes with large amounts of water for 15 minutes. Seek medical attention.
Skin Contact
Wash hands thoroughly with soap and water.

SECTION VI -- Spill, Leak and disposal Procedure
Spills and Leaks: Dig up the soil that kit material has spilled on. If spilled on hard surface soak up spill and wash
with detergent and water.
Disposal: Dispose of soil with oily soil. Dispose of cleanup absorbent with other absorbent material.

SECTION VII -- Special Precautions
Respiratory Protection:
None required if dye cube not crushed to powder. If crushed use dust mask.

Ventilation:
Use in open air.
Protective Gloves:
Always use protective vinyl or polyethylene gloves.
Eye Protection:
Always wear safety glasses

SECTION VIII --Special Precautions
Storage Information:
Keep away from temperatures greater than 140^{o}F (Adhesive for dye cube may melt). Dye cube may crack with sudden
shock at temperatures less than 32 ^{o}F**. Avoid inhaling any dust from dye cube!**

DOT Class - Non flammable

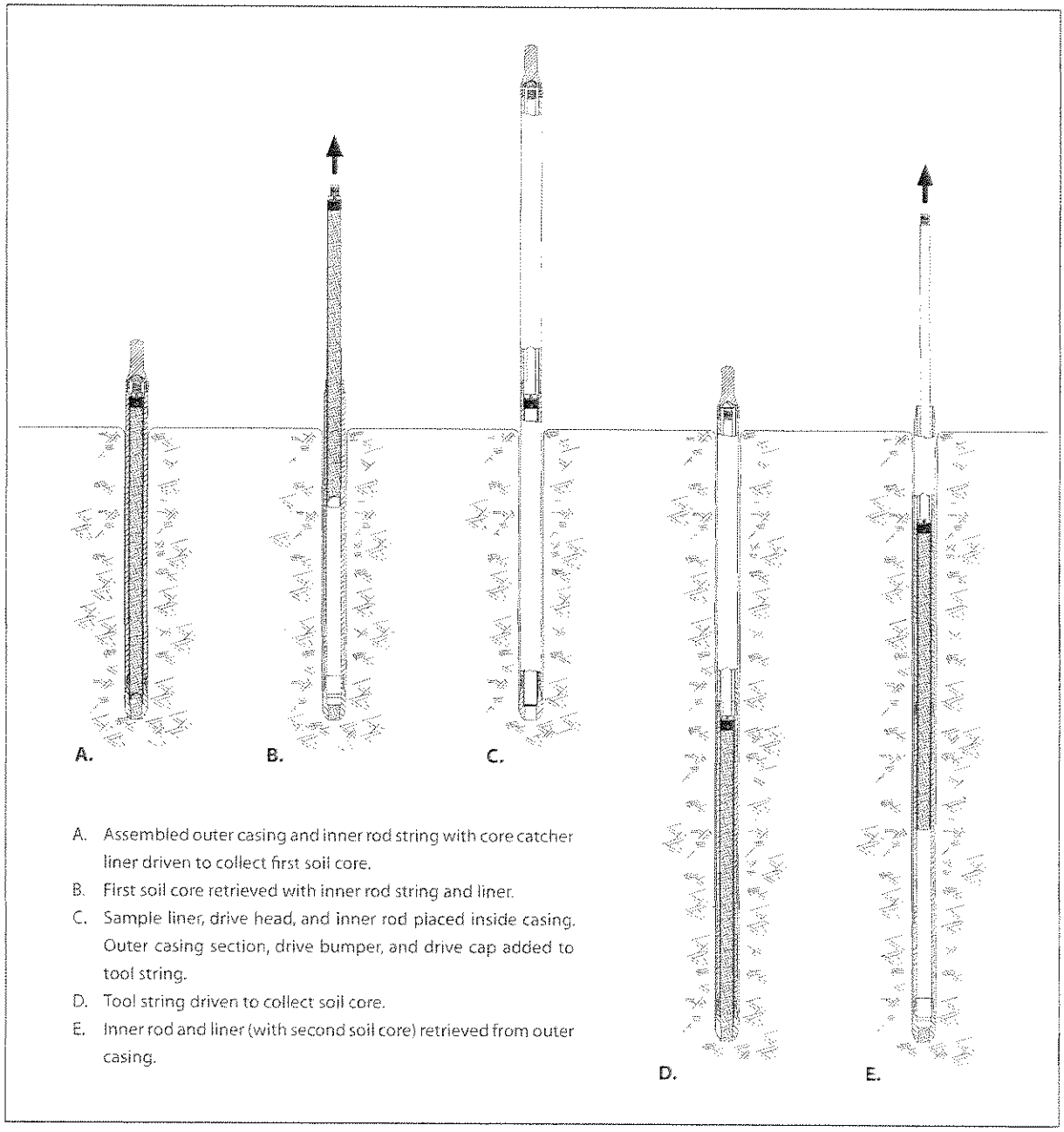
GEOPROBE® DT22 DUAL TUBE SOIL SAMPLING SYSTEM

CONTINUOUS CORE SOIL SAMPLER

STANDARD OPERATING PROCEDURE

Technical Bulletin No. MK3140

PREPARED: November, 2006



A. Assembled outer casing and inner rod string with core catcher liner driven to collect first soil core.
B. First soil core retrieved with inner rod string and liner.
C. Sample liner, drive head, and inner rod placed inside casing. Outer casing section, drive bumper, and drive cap added to tool string.
D. Tool string driven to collect soil core.
E. Inner rod and liner (with second soil core) retrieved from outer casing.

OPERATION OF THE DUAL TUBE 22 SOIL SAMPLING SYSTEM

Geoprobe Systems®

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1.0 OBJECTIVE

The objective of this procedure is to collect a representative soil sample at depth through an enclosed casing and recover it for visual inspection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe®: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling, soil conductivity and contaminant logging, grouting, and materials injection.
** Geoprobe® is a registered trademark of Kejr Engineering, Inc., Salina, Kansas*

DualTube 22 Soil Sampling System: A direct push system for collecting continuous core samples of unconsolidated materials from within a sealed casing of Geoprobe® 2.25-inch (57 mm) OD probe rods. Samples are collected and retrieved within a liner that is threaded onto the leading end of a string of Geoprobe® 1.25-inch (32 mm) OD probe rods and inserted to the bottom of the outer casing. Collected samples measure up to approximately 800 ml in volume in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core.

Liner: A 1.375-inch (35 mm) OD thin-walled, PETG tube that is inserted into the outer casing on the leading end of the inner rod string for the purpose of containing and retrieving core samples. Liners are available in two configurations; a simple open tube or a tube with a core catcher permanently attached to the leading end. Nominal liner lengths include 24 inches, 36 inches, 1 meter, and 48 inches.
***Nominal liner length identifies the length of tools with which the liner is used (see Page 8). The actual end-to-end lengths of the various DT22 liners will differ from the specified nominal lengths.*

Core Catcher: A dome-shaped device positioned at the leading end of a liner to prevent loss of collected soil during retrieval of the liner and soil core. Flexible fingers at the top of the core catcher are pushed outward by soil entering the liner during advancement of the tool string. As the filled liner is subsequently retrieved, the fingers of the core catcher move back inward, effectively closing off the end of the liner and limiting soil loss. The core catcher designed for the DT22 system is made of PETG material and is permanently fused to the liner.

2.2 Discussion

Dual tube sampling gets its name from the fact that two sets of probe rods are used to retrieve continuous soil core samples from the subsurface. One set of rods is driven into the ground as an outer casing (Fig. 2.1). These rods receive the driving force from the hammer and provide a sealed casing through which soil samples may be recovered. The second, smaller set of rods are placed inside the outer casing with a sample liner attached to the leading end of the rod string (Fig. 2.1). These smaller rods hold the liner in place as the outer casing is driven to fill the liner with soil. The inner rods are then retracted to retrieve the full liner.

Standard Geoprobe® 2.25-inch OD probe rods provide the outer casing for the DT22 DualTube Soil Sampling System. A cutting shoe is threaded into the leading end of the rod string. When driven into the subsurface, the cutting shoe shears a 1.125-inch OD soil core which is collected inside the casing in a clear plastic liner.

The second set of rods in the DT22 system are standard Geoprobe® 1.25-inch OD probe rods. A sample liner is attached to the end of these smaller rods and then inserted into the casing. The 1.25-inch rods hold the liner tight against the cutting shoe as the outer casing is driven to collect the soil core. Once filled with soil, the liner is removed from the bottom of the outer casing by lifting out the 1.25-inch rods.

The outer, 2.25-inch probe rods provide a cased hole through which to sample. The main advantage of sampling through a cased hole is that there is no side slough to contend with. In addition, the outer casing effectively seals the probe hole when sampling through perched water tables. These factors mean that sample cross-contamination is eliminated. The DT22 sampling system is therefore ideal for continuous coring in both saturated and unsaturated zones.

Solid Drive Tip

A Solid Drive Tip (22956) can be placed on the leading end of the 1.25-inch probe rod string in place of a sample liner (Fig. 2.2). When installed in the outer casing, the drive tip firmly seats within the cutting shoe and effectively seals the tool string as it is driven into the subsurface. This enables the operator to advance the outer casing to the bottom of a pre-cored hole or through undisturbed soil to reach the top of the sampling interval.

Grouting

The DT22 system allows bottom-up grouting through the primary tool string. This means that a cement or bentonite grout mix can be pumped through the outer casing as it is withdrawn from the ground. This is in contrast to most other soil samplers which require driving a second set of tools back down the probe hole in order to deliver the grout mix.

Monitoring Well Installation

An expendable cutting shoe enables the operator to install a Geoprobe® Prepacked Screen Monitoring Well through the outer casing of the DT22 Dual Tube System. After the collection of continuous soil cores to the desired depth, prepacked screens can be inserted to the bottom of the outer casing on the leading end of a PVC riser string. The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

Groundwater Profiler

The DT Groundwater Profiler Kit (GW2100) brings groundwater sampling to the dual tube system. With these tools, operators can perform soil sampling, groundwater sampling, and slug testing at multiple depth intervals in one probe push.

The DT profiler utilizes a 3/4-inch Schedule 40 PVC screen with a slotted length of 12 inches. Standard Geoprobe® extension rods are used to install and retrieve the screen through the cutting shoe on the leading end of the outer casing. This ability to install and retrieve the screen with the outer casing in place allows for alternating of soil and groundwater sampling and slug testing in a single probe push.

For specific information on using the DT profiler, refer to *Dual Tube (DT21) Groundwater Profiler Kit - Installation and Operation Instructions* (Geoprobe® Instructional Bulletin No. 19275).

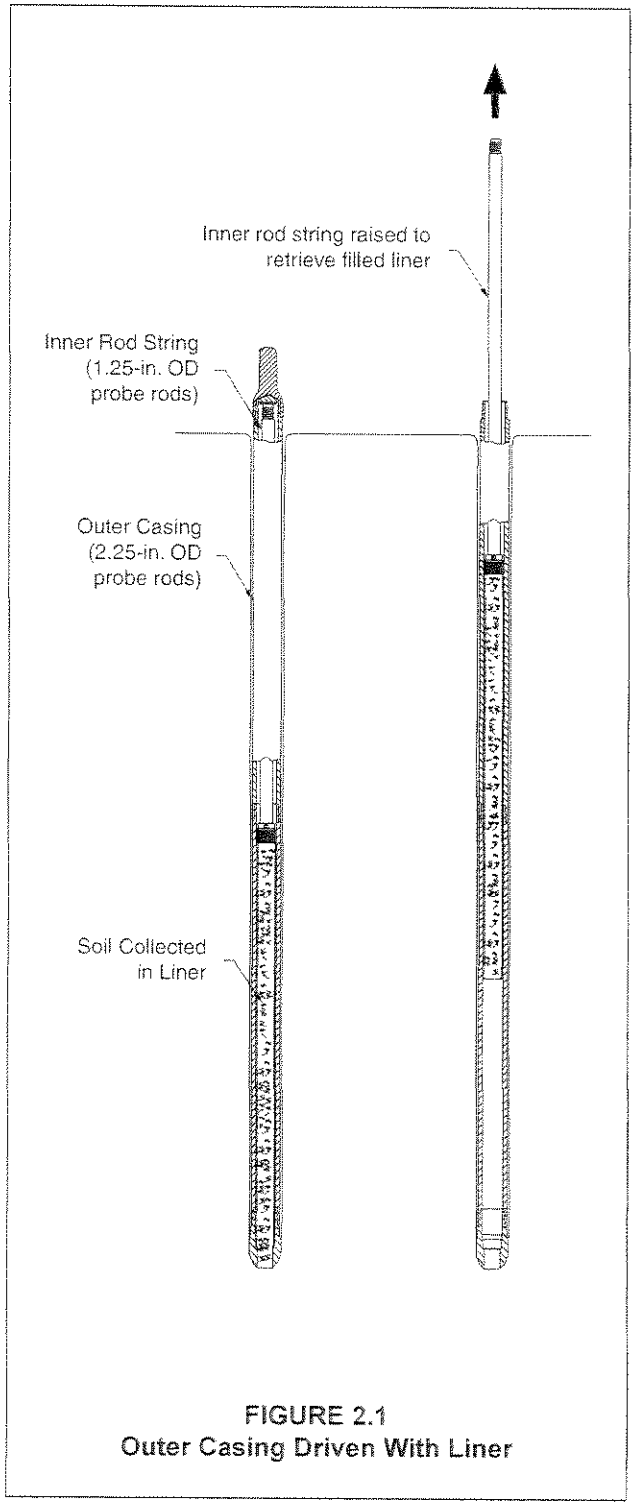


FIGURE 2.1
Outer Casing Driven With Liner

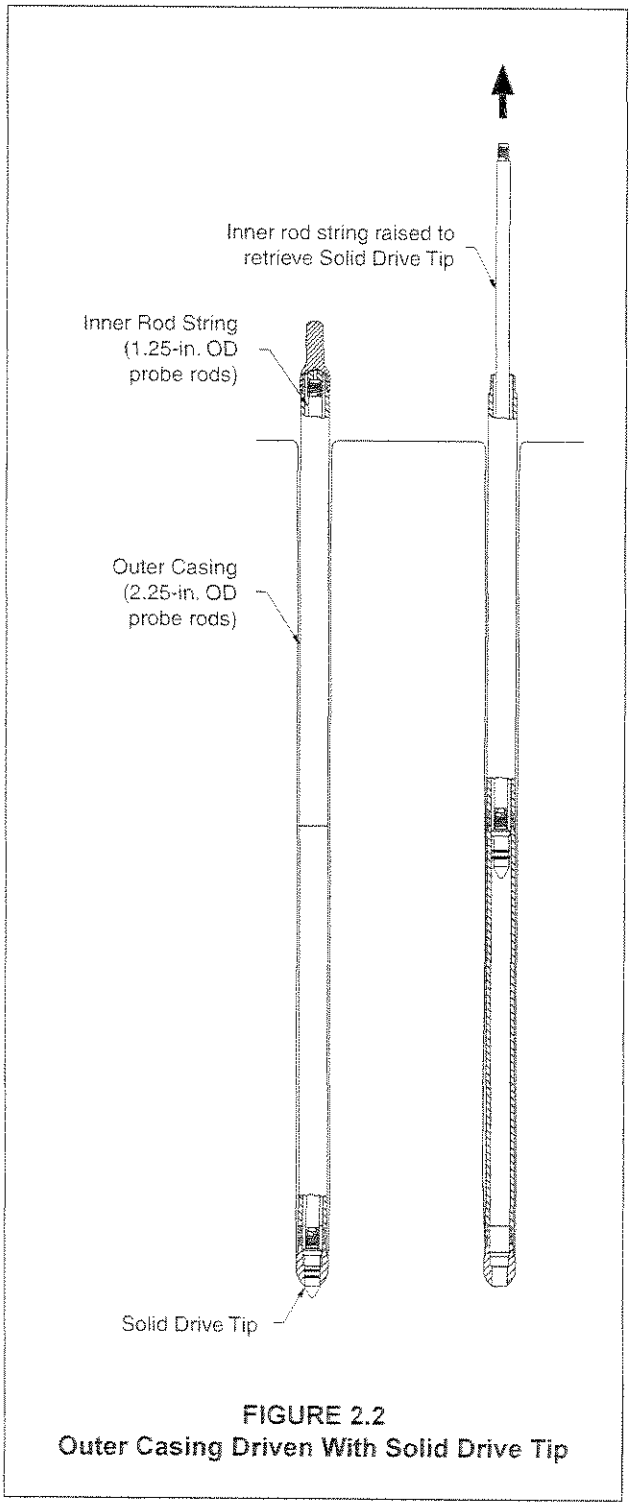


FIGURE 2.2
Outer Casing Driven With Solid Drive Tip

3.0 REQUIRED EQUIPMENT

The following equipment is used to recover samples with the Geoprobe® Dual Tube 22 Soil Sampling and probing systems. Refer to Figure 3.1 for parts identification.

DUAL TUBE 22 SAMPLER PARTS	QUANTITY	PART NUMBER
DT21 Drive Bumper, Pkg. of 5	-1-	DT4010K
DT22 Threadless Drive Cap, for 1.25-inch rods	-1-	22955
DT22 Cutting Shoe, Standard	-1-	25341
DT22 Expendable Cutting Shoe Holder	-1-	29402
DT22 Expendable Cutting Shoe, 2.375 in. OD	variable	DT4045
O-rings for Expendable Cutting Shoe, Pkg. of 50	variable	DT4045R
DT21 Liner Drive Head Assembly, for 1.25-inch rods	-1-	DT4052
Rebuild Kit for DT21 Liner Drive Head	-1-	DT4051K
DT21 Solid Drive Tip, for 1.25-inch rods	-1-	22956
O-rings for Solid Drive Tip, Pkg. of 25	variable	DT4070R
DT21 Vinyl End Caps, Pkg. of 100 (50 pair)	variable	DT4026K
DT21 Liner, PETG, 48-inch, Box of 50*	variable	DT4048K
DT21 Liner With Core Catcher, PETG, 48-inch, Box of 50*	variable	DT4148K
DT21 Liner Grooving Tool	-1-	18170
Universal Liner Holder	-1-	22734

GEOPROBE TOOLS AND EQUIPMENT	QUANTITY	PART NUMBER
Light Weight Center Rod, 1.25 inch OD x 48 inches	variable	21900
Probe Rod, 1.25 inch OD x 24 inches	variable	AT1224
O-rings for 2.125-inch Probe Rods	variable	AT2100R
GH60 Threadless Drive Cap for 2.25 inch rods*	-1-	31530
GH40 Threadless Drive Cap for 2.25 inch rods	-1-	31405
GH40 Threaded Drive Cap for 2.25 inch rods	-1-	25362
Pull Cap, for 2.25-inch rods	-1-	25298
Probe Rod, 2.25 inches OD x 48 inches*	variable	25300
Rod Grip Pull System, for GH40 Hammer	-1-	29461
Rod Grip Pull Handle, for GH60 Hammer and 2.25-inch rods**	-1-	29385

ADDITIONAL TOOLS	QUANTITY
Hex Key, 3/32 in.	-1-
Utility Knife (with straight blade)	-1-
Pipe Wrench	-2-

* The considerable percussive force of the GH60 Hydraulic Hammer may result in reduced tool life for components such as the DT21 Drive Bumper and rod string as compared to operation with the GH40 Hydraulic Hammer.

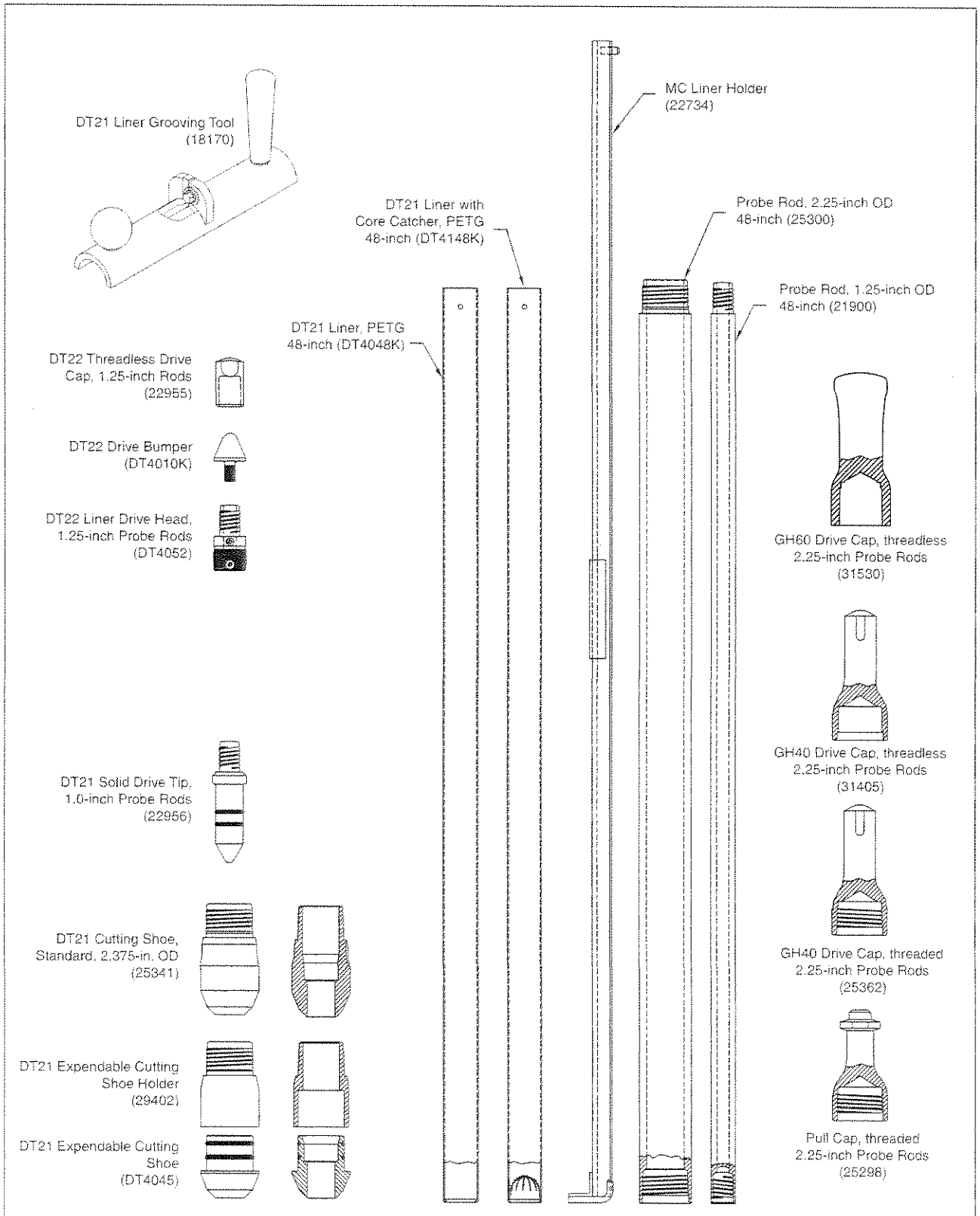


FIGURE 3.1
Dual Tube 22 Soil Sampling System Parts

3.1 Tool Options

Three major components of the DT22 Soil Sampling System are probe rods, sample liners, and cutting shoes. These items are manufactured in a variety of sizes to fit the specific needs of the operator. This section identifies the specific tool options available for use with the DT22 Dual Tube System.

Probe Rods

Standard Geoprobe® 1.25-inch (32 mm) OD and 2.25-inch (57 mm) OD probe rods are required to operate the DT22 Soil Sampling System. The probe rods are available in 48 inches (1,219 mm) lengths. Both rod sets (1.25-inch and 2.25-inch) must be of the same length.

Sample Liners

Sample liners are made of a heavy-duty clear plastic for convenient inspection of the soil sample. A nominal length of 48 inches is available with an OD of 1.375 inches (35 mm).

Sample liners with integral core catchers are available in a nominal length of 48 inches. Utilize the core catcher liners when sampling flowing sands, noncohesive soils, extremely dry soils, or any other materials that fall from the liner during retrieval. DT22 core catcher liners are used with the same equipment as open sample liners. No special tooling or adapters are required.

Cutting Shoes

The standard DT22 Cutting Shoe is available for use with the DT22 Dual Tube System (Fig. 3.2). The DT22 sampling system may also employ an expendable cutting shoe. In this arrangement, a DT22 Expendable Cutting Shoe Holder (29402) is threaded into the leading end of the outer casing. A DT21 Expendable Cutting Shoe (DT4045) is then inserted into the holder. Upon completion of soil sampling, the outer casing is withdrawn slightly. The expendable cutting shoe detaches from the holder, leaving an open casing through which a prepacked screen monitoring well may be installed. Dimensions for the expendable cutting shoe are the same as the standard cutting shoe (ID = 1.125 in. (29 mm) and OD = 2.375 in. (60 mm)).

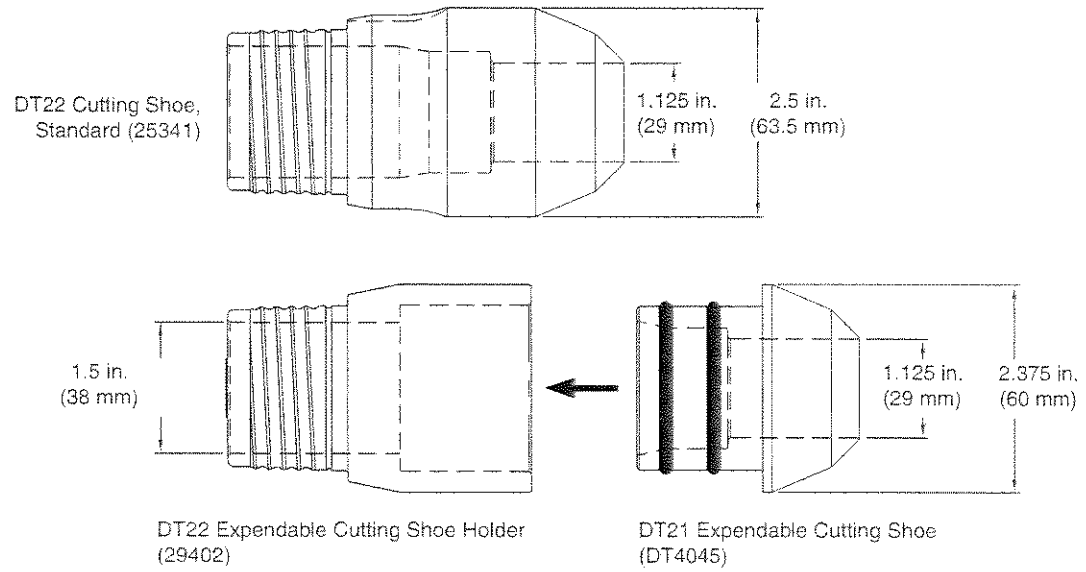


FIGURE 3.2
Cutting Shoe Options for the DT22 Dual Tube Soil Sampling System

4.0 OPERATION

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the sampling system according to project requirements. Parts should also be inspected for wear or damage. During sampling, a clean new liner is used for each soil core.

4.2 Operational Overview

The DT22 Soil Sampling System is designed to collect continuous soil cores. Sampling may begin either from ground surface or a predetermined depth below ground. Once sampling begins, consecutive soil cores must be removed as the outer casing is advanced to greater depths.

When sampling is to begin at the ground surface, the first soil core should be collected using a core catcher liner to maximize sample recovery (Fig. 4.1-A). This is especially true when the first core is composed of dry, loose soil. Upon removal of the first liner and soil core (Fig. 4.1-B), a new liner is inserted to the bottom of the outer casing on the end of an inner rod. A section of outer casing is added to the tool string (Fig. 4.1-C) and the entire tool string is driven to fill the liner with soil (Fig. 4.1-D). The filled liner is removed from the outer casing to retrieve the second soil core (Fig. 4.1-E). A new liner is then inserted to the bottom of the outer casing and the process is repeated over the entire sampling interval.

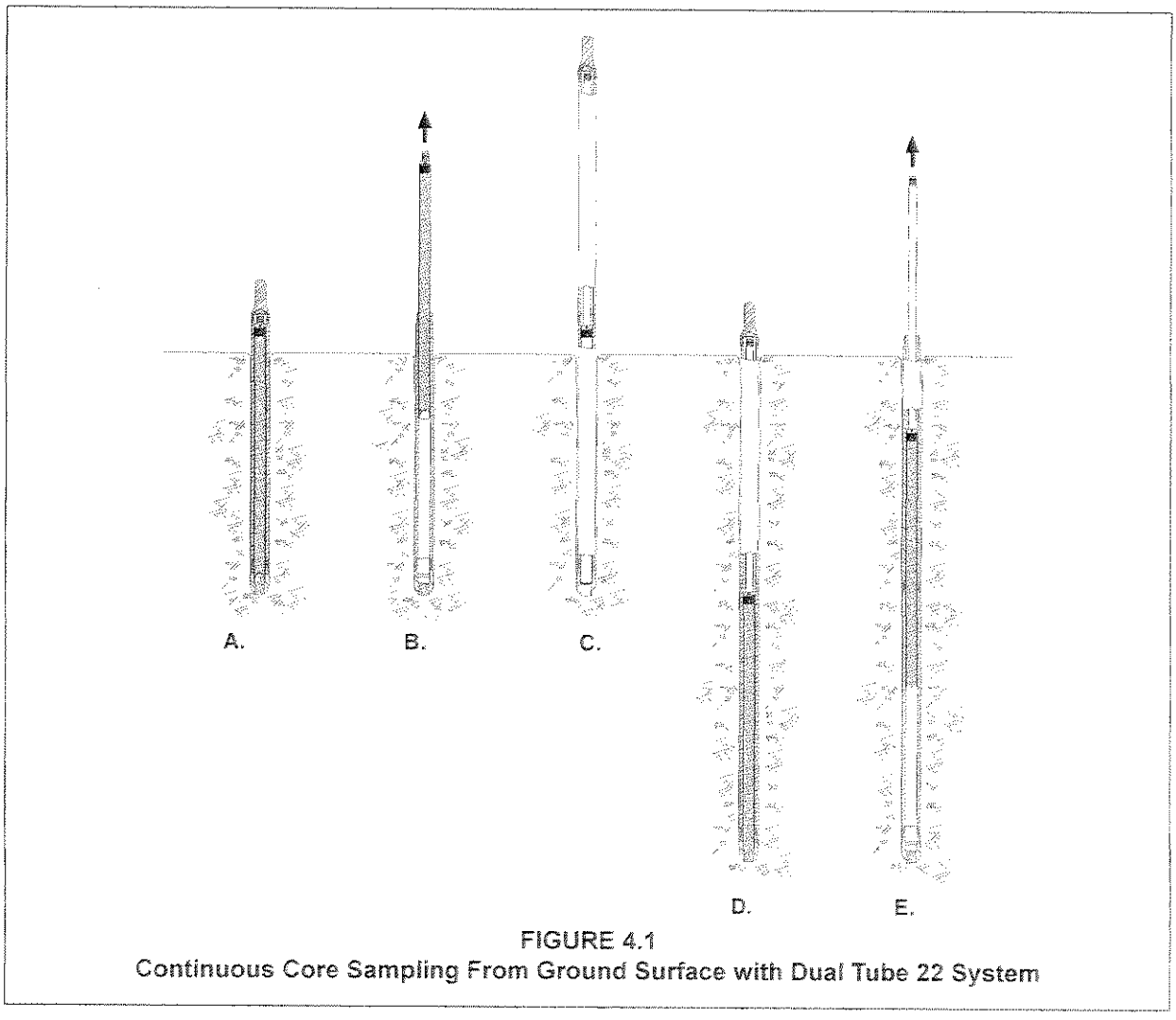


FIGURE 4.1
Continuous Core Sampling From Ground Surface with Dual Tube 22 System

When the sampling interval begins at some depth below ground surface, a DT22 Solid Drive Tip is installed in the outer casing and the entire assembly is driven from ground surface directly through undisturbed soil (Fig. 4.2-A). This enables the operator to reach the top of the sampling interval without stopping to remove unwanted soil cores. Once the interval is reached, the solid drive tip is removed (Fig 4.2-B) and sampling continues as described in the preceding paragraphs (Fig. 4.2-C, Fig. 4.2-D, and Fig. 4.2-E).

Specific instructions for the assembly and operation of the DT22 Dual Tube Soil Sampling System are given in the following sections.

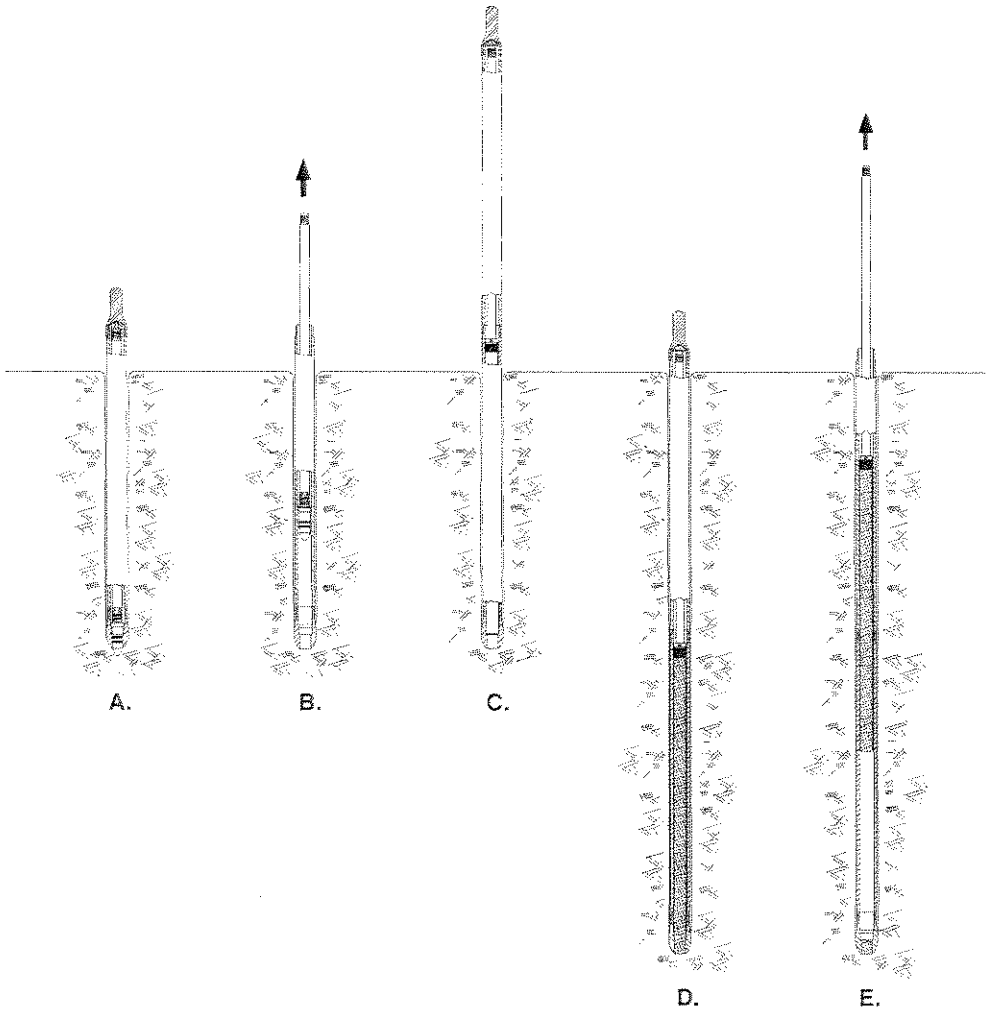


FIGURE 4.2
Outer Casing Driven Through Undisturbed Soil to Begin Sampling with DT22 System

4.3 Assembling and Driving the Outer Casing Using a DT21 Solid Drive Tip

If soil sampling is to begin at some depth below ground surface, the outer casing of the DT22 Dual Tube System can be driven to the top of the sampling interval with a DT22 Solid Drive Tip installed in the leading end. The solid drive tip seals the outer casing as it is driven to depth. Once the desired sampling interval is reached, the solid drive tip is removed to allow collection of the first soil core. This section describes assembling and driving the outer casing using the DT22 Solid Drive Tip.

1. When using a DT22 Standard Cutting Shoe (25341) install an O-ring (AT2100R) at the base of the threads as shown in Figure 4.3. If using an expendable cutting shoe, install an AT2100R O-ring on the DT22 Expendable Cutting Shoe Holder (29402) and two DT4045R O-Rings on the DT21 Expendable Cutting Shoe (DT4045) (Fig. 4.3).

2. Thread the DT22 Cutting Shoe or DT22 Expendable Point Holder into the leading end of a 2.25-inch OD Probe Rod (25300). Completely tighten the cutting shoe or cutting shoe holder using a pipe wrench.

3. Install an O-ring (DT4070R) in both grooves of the DT22 Solid Drive Point (22956) (Fig.4.4).

4. Thread the solid drive point into the female end of a 1.0-inch OD probe rod of the same length as the 2.125-inch probe rod (outer casing).

5. Lubricate the O-rings on the solid drive point with a small amount of deionized water. Insert the point and probe rod into the outer casing until the point partially extends from the bottom of the cutting shoe.

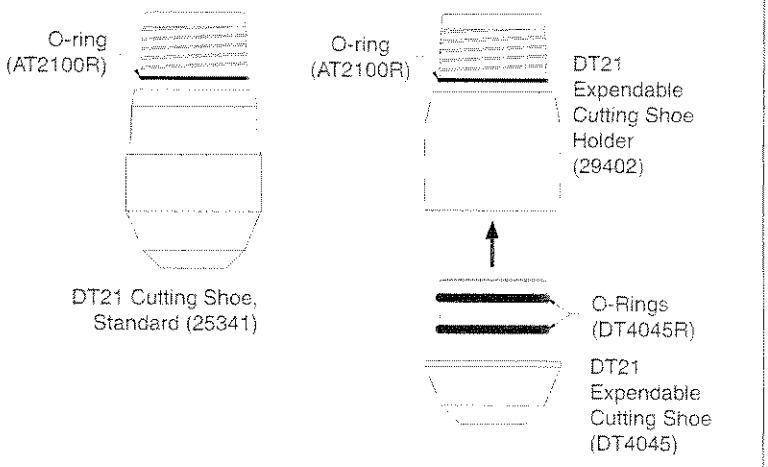


FIGURE 4.3
DT22 Cutting Shoes Utilize O-ring Seals

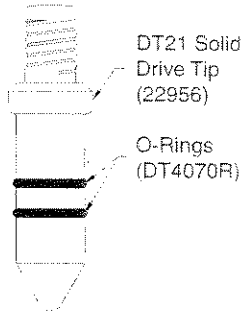


FIGURE 4.4
Solid Drive Point Utilizes Two O-Rings

6. Place a DT22 Threadless Drive Cap (22955) on top of the inner rod (Fig. 4.5). This drive cap is threadless for quick installation/ removal, yet still provides protection for the probe rod threads.

7. Thread a GH40 Drive Cap (25362) or GH60 Threadless Drive Cap (25296) onto the 2.25-inch probe rod (outer casing) as shown in Figure 4.5.

   For GH40 Users: Current 25362 Drive Caps are manufactured using a process that leaves an angled surface inside the cap (Fig. 4.6). This provides room for the Threadless Drive Cap (22955).

   For GH60 Users: A GH60 Threadless Drive Cap (25296) is recommended for the 2.25-inch probe rods when driving the DT22 system. The GH60 Threaded Drive Cap (25362) secures the inner rod string during percussion so that the outer casing and inner rod string are advanced as one assembly. The standard threadless drive cap may allow the outer casing to advance slightly ahead of the inner rod string, resulting in poor sample recovery and alignment problems when adding rods to the tool string.

   NOTE: Do not allow the threaded drive cap to unthread more than approximately 1/8 inch while driving the tool string. Failure to keep the drive cap tight during percussion will fuse the drive cap to the outer casing and permanently damage the threads of both the drive cap and top probe rod.

8. Place the assembled outer casing section under the direct push machine for driving. Position the casing directly under the hammer with the cutting shoe centered between the toes of the probe foot.

9. Lower the hydraulic hammer onto the drive cap and advance the outer casing into the subsurface.

10. Raise the hydraulic hammer and remove the drive cap from the outer casing and the threadless drive cap from the inner rod string.

11. Place an O-ring (AT2100R) on the outer casing section that extends from the ground (Fig. 4.7).

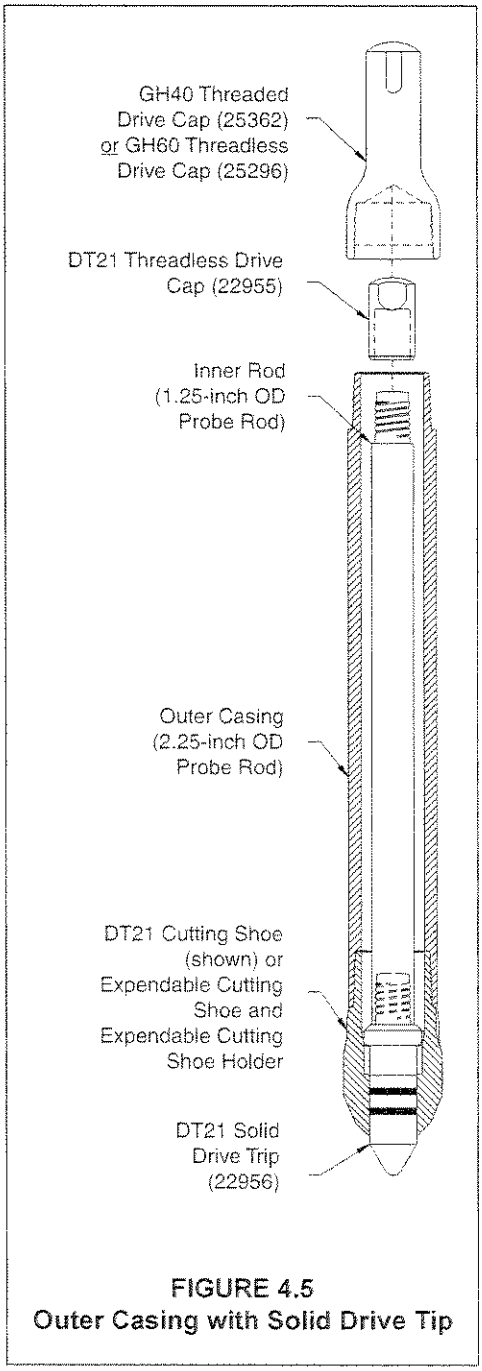


FIGURE 4.5
Outer Casing with Solid Drive Tip

12. Thread a 1.0-inch probe rod onto the inner rod string. Place a 2.25-inch probe rod over the inner rods and thread it onto the outer casing (Fig. 4.8). Completely tighten the outer casing using a pipe wrench.

13. Place the threadless drive cap on top of the inner rod. Thread the 2.25-inch drive cap over the threadless drive cap and onto the outer casing.

14. Lower the hydraulic hammer onto the drive cap and advance the outer casing into the subsurface.

    Repeat Steps 10-13 until the leading end of the outer casing is at the top of the proposed sampling interval. Continue with Step 15 to remove the DT22 Solid Drive Point for sampling.

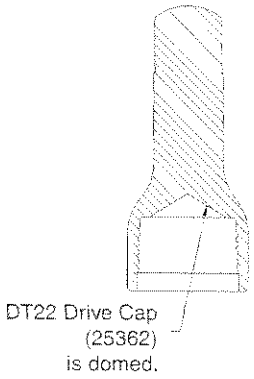


FIGURE 4.6
DT22 Drive Cap

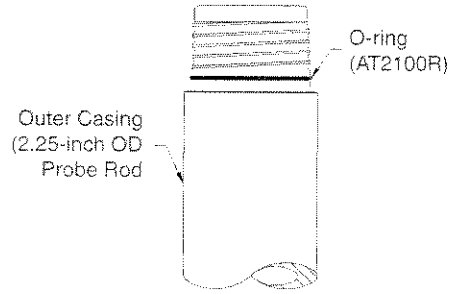


FIGURE 4.7
Outer Casing Joints are Sealed with O-Rings

15. Raise the hydraulic hammer and retract the probe derrick to provide access to the top of the tool string.

16. Unthread the 2.25-inch drive cap and remove the threadless drive cap from the inner rods.

17. Thread a 1.25-inch OD probe rod onto the inner rod string. Lift and remove the inner rods from the outer casing. The DT21 Solid Drive Point is removed from the leading end of the casing with the inner rods.

    The outer casing is now ready for sampling.

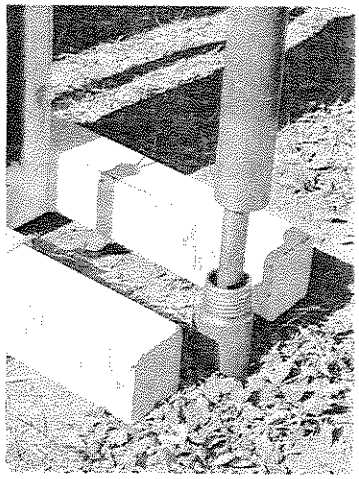


Figure 4.8. Place a 2.25-inch probe rod over the 1.25-inch rod and thread it onto the outer casing string.

4.4 Liner Drive Head Assembly

The main function of the DT22 Liner Drive Head Assembly (DT4052) is to connect a liner to the leading end of the inner rod string. This enables the inner rods to hold the liner tight against the cutting shoe to fill the liner with soil as the outercasing is driven. The inner rods are then used to retrieve the liner and soil core from within the outer casing.

The liner drive head assembly includes an internal check ball to improve sample recovery (Fig. 4.9) A considerable vacuum is created below the filled liner as it is lifted from the bottom of the outer casing. Because the inner rod string and liner drive head are hollow, atmospheric air can travel through the rods creating a positive pressure differential above the soil core during retrieval. The check ball seals the liner drive head to eliminate air flow into the liner which could otherwise push the soil sample out of the liner. The check ball also allows air to escape up through the liner drive head and inner rod string when lowering a new liner down the outer casing and as soil enters the liner during sampling.

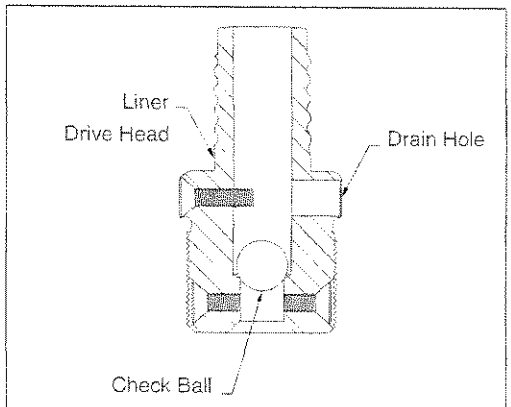


FIGURE 4.12
Cross-Section of Liner Drive Head

Saturated conditions can also challenge sample recovery. Water enters the outer casing either from the saturated formation or is deliberately poured from the ground surface to keep flowing sands out of the casing. As with air in unsaturated formations, the check ball lets water pass through the liner drive head as a new

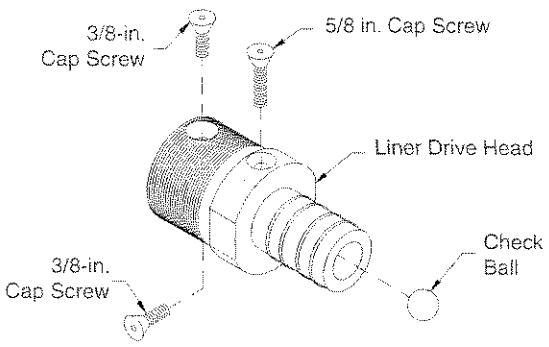


FIGURE 4.10
Liner Drive Head Assembly Components

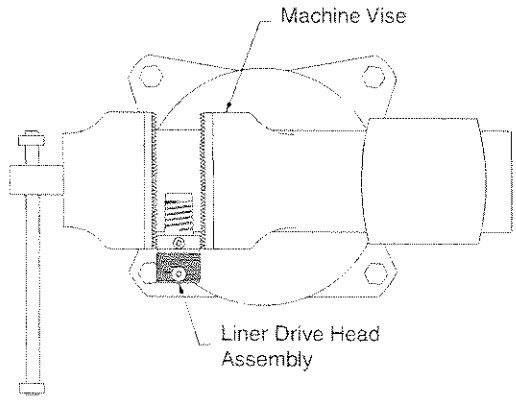


FIGURE 4.11
Place Liner Drive Head in Vise

liner is lowered to the bottom of the casing and during sampling as the liner is filled with soil. The check ball then seals the drive head during retrieval so that water draining from the inner rods does not wash the sample out the bottom of the liner. A drain hole located on the side of the liner drive head (Fig. 4.9) allows water to exit the inner rods and travel harmlessly along the outside of the liner.

The liner drive head assembly is made up of five parts as shown in Figure 4.10. The two 3/8-inch flat head socket cap screws are used to attach liners to the liner drive head. The longer 5/8-inch flat head socket cap screw holds the stainless steel check ball within the liner drive head. To disassemble the liner drive head for cleaning, simply unthread the 5/8-inch cap screw and remove the check ball.

Instructions for attaching a liner to the DT22 Liner Drive Head Assembly (DT4052) are given below.

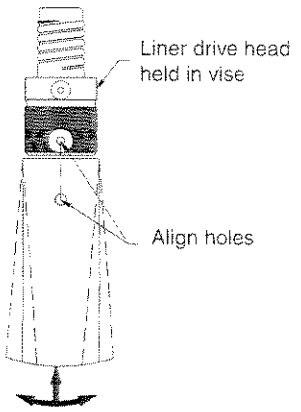


FIGURE 4.12
Push Liner Onto Liner Drive Head

1. Visually inspect the liner drive head assembly to ensure that the check ball moves freely within the drive head and the drain hole is unobstructed.

2. Place the liner drive head assembly in a machine vise so that either one of the 3/8-inch caps screws is on top as shown in Figure 4.11.

   NOTE: Only one 3/8-inch cap screw is used to attach a liner to the liner drive head assembly. Two 3/8-inch cap screws are included on the drive head to provide a backup in case one incurs thread damage. Either cap screw may be used to attach the liner.

3. Remove the 3/8-inch cap screw using a 3/32-inch hex key.

4. Place the open end of a DT21 Liner against the bottom of the liner drive head. Align the hole in the liner with the hole in the liner drive head as shown in Figure 4.12. Wiggle the free end of the liner back-and-forth while pushing the liner onto the drive head (Fig. 4.12).

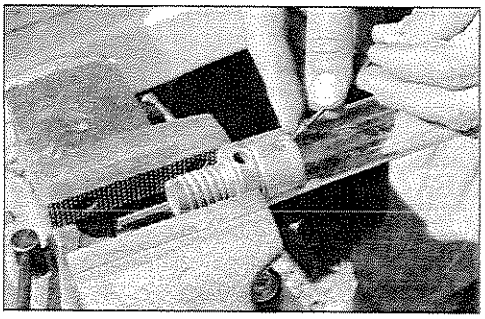


Figure 4.13. Thread cap screw into liner drive head to secure liner.

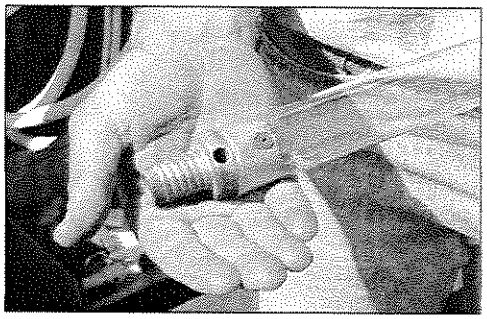


Figure 4.14. Liner attached to liner drive head and ready for sampling.

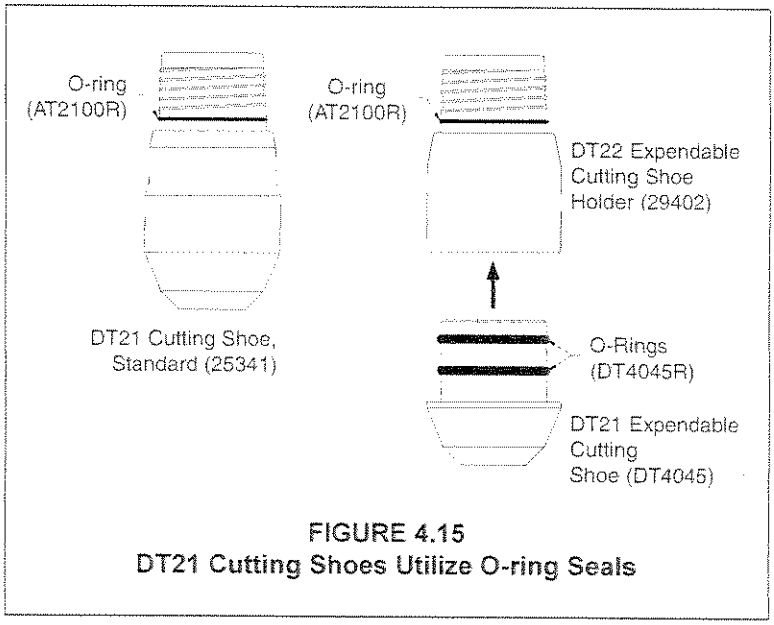


FIGURE 4.15
DT21 Cutting Shoes Utilize O-ring Seals

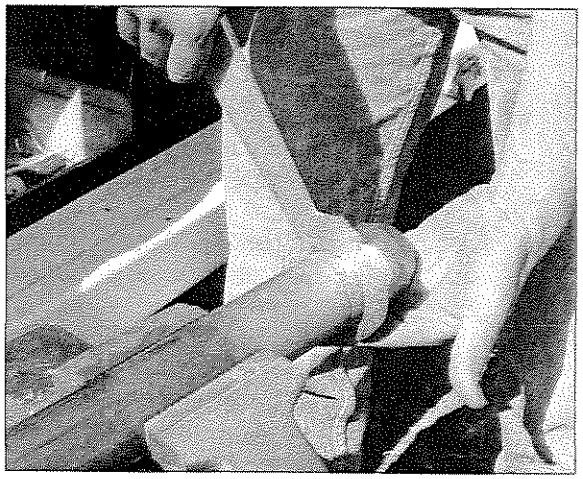


Figure 4.16. Place probe rod (outer casing) in vise and tighten cutting shoe with MC Combination Wrench.

5. Thread the 3/8-inch cap screw through the liner and back into the liner drive head (Fig. 4.13). Tighten the cap screw with the 3/32-inch hex key.

   The DT21 Liner is now attached to the DT22 Liner Drive Head Assembly (Fig. 4.14).

4.5 Soil Core Collection

This section describes collection of continuous soil core samples from within the sealed outer casing of the DT22 Dual Tube Soil Sampling System. The procedure is written for a sampling series that begins at the ground surface. If sampling is to begin after driving the outer casing through undisturbed soil using a DT21 Solid Drive Tip, skip ahead to Step 13 of this section.

1. Install an O-ring (AT2100R) at the base of the threads on the Standard Cutting Shoe (25341) as shown in Figure 4.15. If using an expendable cutting shoe, install an AT2100R O-ring on the expendable cutting shoe holder and two DT4045R O-Rings on the expendable cutting shoe (Fig. 4.15).

2. Thread the DT22 Cutting Shoe or DT22 Expendable Point Holder into the leading end of a 2.25-inch OD Probe Rod (25300). Completely tighten the cutting shoe or cutting shoe holder using a machine vise and pipe wrench as shown in Figure 4.16.

3. Attach a DT22 Liner Drive Head Assembly (DT4052) to a new liner as described in Section 4.4. A core catcher liner is recommended for when the first soil core begins at ground surface as this configuration will provide maximum sample recovery.

4. Insert the liner and drive head into the 2.25-inch OD probe rod such that the core catcher contacts the cutting shoe as shown in Figure 4.17.

5. Place a DT21 Drive Bumper (DT4010) on top of the liner drive head (Figure 4.17).

6. Thread a GH40 Drive Cap (25362) or GH60 Threaded Drive Cap (25296) onto the 2.25-inch probe rod (outer casing) as shown in Figure 4.17.

   NOTE: Do not allow the threaded drive cap to unthread more than approximately 1/8 inch while driving the tool string. Failure to keep the drive cap tight during percussion will fuse the drive cap to the outer casing and permanently damage the threads of both the drive cap and top probe rod.

7. Place the assembled outer casing section under the direct push machine for driving. Position the casing directly under the hydraulic hammer with the cutting shoe centered between the toes of the probe foot.

8. Lower the hydraulic hammer onto the drive cap and advance the outer casing into the subsurface using continuous percussion.

9. Raise the hydraulic hammer and move the probe assembly back to provide access to the top of the tool string.

10. Remove the drive cap and drive bumper.

11. Thread a 1.25-inch Light Weight Center Rod onto the liner drive head. Rotate the probe rod and liner assembly two or three revolutions to shear the soil core at the bottom of the liner. Lift the probe rod and filled liner from the outer casing to retrieve the first soil core.

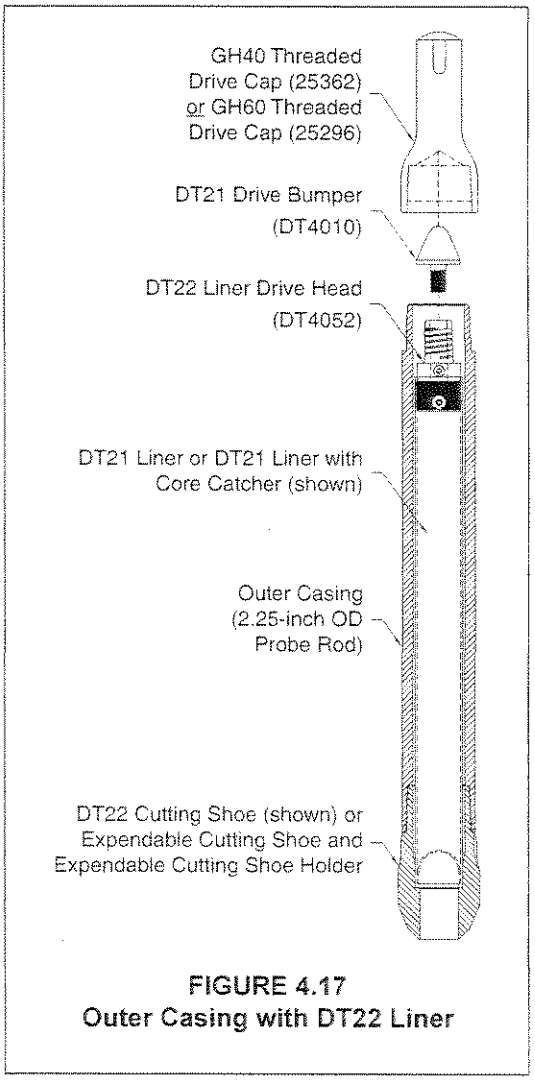


FIGURE 4.17
Outer Casing with DT22 Liner

12. Remove the filled liner from the liner drive head as described in Section 4.6. Prepare the soil core for subsampling or storage as specified by the project plan.

13. Place an O-ring (AT2100R) in the groove just below the male threads on the top section of the outer casing (Fig. 4.18).

14. Thread a 1.25-inch probe rod onto an assembled DT22 Liner Drive Head (DT4052) and DT21 Liner (Fig. 4.19).

15. Insert the liner and probe rod into the outer casing (Fig. 4.20). The inner rod will extend past the top of the outer casing if only one section of casing was previously driven into the ground. If the casing was driven to a greater depth, continue adding 1.0-inch probe rods until the last rod extends from the casing.

16. Place a 2.25-inch probe rod over the inner rods and thread it onto the outer casing (Fig. 4.21). Completely tighten the outer casing using a pipe wrench.

17. Place a DT21 Drive Bumper (DT4010) on top of the inner rod as shown in Figure 4.22.

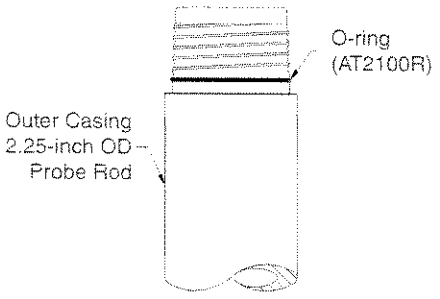


FIGURE 4.18
Outer Casing Joints are Sealed with O-Rings

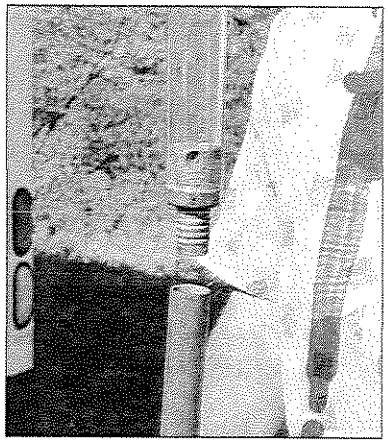


Figure 4.19. Thread liner and liner drive head into 1.25-inch Light Weight Center Rod.

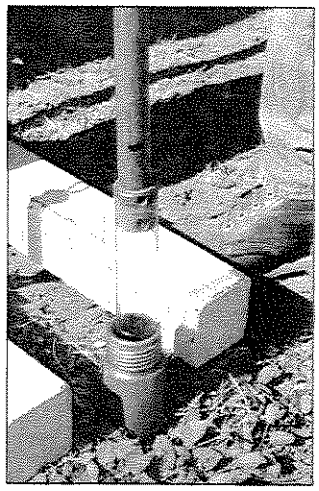


Figure 4.20. Lower liner to bottom of outer casing on leading end of inner rods.

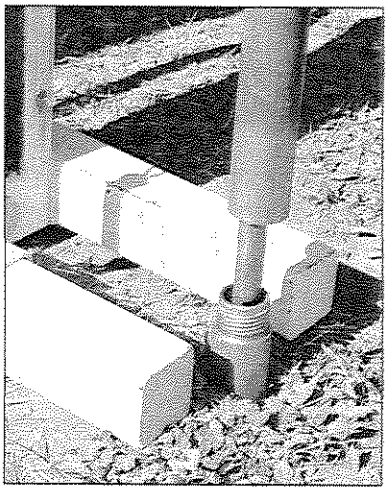


Figure 4.21. Place a 2.125-inch probe rod over the 1.0-inch probe rod and thread it onto the outer casing string.

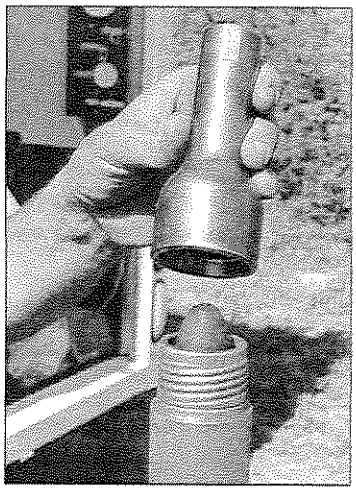


Figure 4.22. Place a drive bumper on top of the inner rods and thread a drive cap onto the outer casing.



Figure 4.23. Thread a 1.0-inch probe rod onto inner rod string to retrieve filled liner.

18. Thread a Drive Cap (25362 or 25296) onto the 2.25-inch probe rod (Fig. 4.22). Completely tighten the drive cap with a pipe wrench. **(Refer to notes in Step 6 regarding Drive Caps.)**

19. Lower the hydraulic hammer onto the drive cap and advance the outer casing one liner length into the subsurface to collect the first soil core. Apply hammer percussion to the tool string as this helps move soil through the cutting shoe and into the liner for increased sample recovery.

20. Raise the hydraulic hammer and retract the probe derrick to provide access to the top of the tool string.

21. Unthread the drive cap and remove the drive bumper.

22. Thread a 1.25-inch Light Weight Center Rod onto the inner rod (Fig. 4.23). Rotate the inner rods two or three revolutions to shear the soil core at the bottom of the liner. Raise the inner rods to retrieve the filled liner.

23. Remove the filled liner from the liner drive head as described in Section 4.6.

(Repeat Steps 13-23 to collect consecutive soil core samples.)

4.6 Removing the DT22 Liner Drive Head from a Filled DT21 Liner

The liner drive head assembly remains attached to the filled liner after retrieval from the outer casing (Fig. 4.24). In order to decontaminate the drive head for further sampling, it must first be removed from the filled liner. This process is easily accomplished using a machine vise and sharp utility knife.

Place the liner drive head in the machine vise such that the 3/8-inch cap screw threaded through the liner is positioned on top. Remove the cap screw with a 3/32-inch hex key.

Using a utility knife, score a line from the top of the liner to the bottom of the drive head (Fig. 4.25). Move the free end of the liner side-to-side until the top of the liner splits and releases from the drive head (Fig. 4.26). The soil core may now be prepared for storage or analysis according to project guidelines.

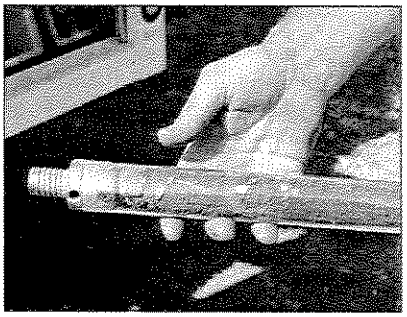


Figure 4.24. Liner drive head remains attached to filled liner after retrieval from outer casing.

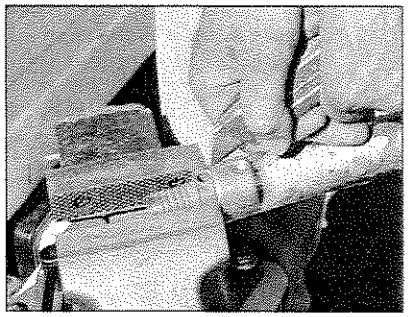


Figure 4.25. Score a line from top of liner to base of liner drive head using a utility knife.

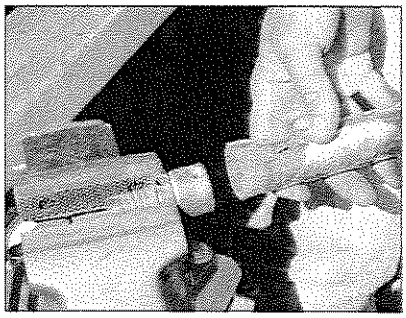


Figure 4.26. Move free end of liner back-and-forth to split liner and free it from the liner drive head.

4.7 Removing a Section of Liner with a DT21 Liner Grooving Tool and Utility Knife

A special tool is needed to help efficiently and safely cut through the thick DT21 liners in order to access the soil sample. The DT21 Liner Grooving Tool (18170, Fig. 4.27) greatly improves the liner cutting process by creating a deep longitudinal groove in the sample liner (Fig. 4.28). The sample liner is then easily cut along the groove with a normal utility knife.

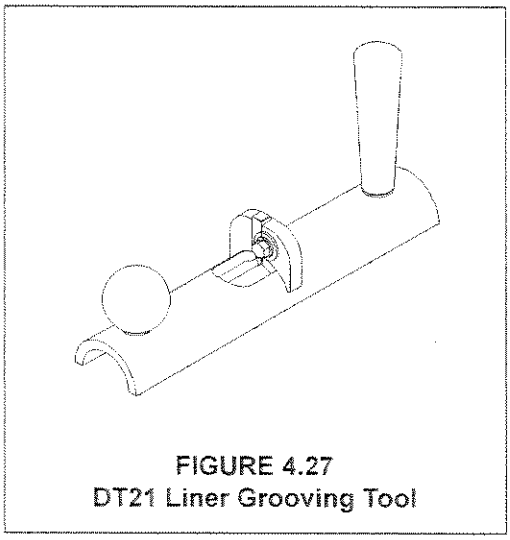


FIGURE 4.27
DT21 Liner Grooving Tool

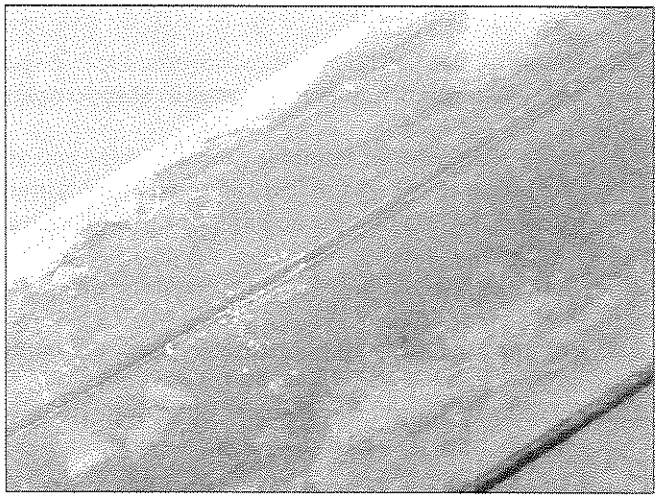


Figure 4.28. Groove in liner created by DT21 Grooving Tool.

Grooving the Liner

Because DT21 liners are flexible and will bend under load, a means of holding the liner is absolutely necessary in order to successfully operate the grooving tool. A Universal Liner Holder (22734) works well for this application.

1. Secure the liner holder in a machine vise or place it on a sturdy table or platform.

2. Lay the filled liner in the holder with the top (drive head) end of the liner toward the "hook" stop and the downhole end toward the "pin" stop (Fig. 4.29).

3. The grooving tool is pulled along the top of the liner to cut a single longitudinal groove. Right-handed operators will generally pull the tool beginning at the left end of the liner while left-handed operators will generally pull the tool beginning at the right end.

   Place the grooving tool on top of the liner with the cutting insert positioned approximately 0.25 inches (6 mm) in from the appropriate end as determined by the operator's dominant hand (Fig. 4.30).

4. Pull the grooving tool across the entire length of the liner by applying steady force to the front (spherical) handle. **For the grooving tool to function correctly, it is very important to put the majority of the pulling force on the front handle.** Only use the back (tapered) handle to guide the tool. When used correctly, the grooving tool will remove material in a continuous string as shown in Figure 4.31.

5. Repeat Steps 3 and 4 to cut a second groove that will allow removal of a section of liner for easier access to the soil sample.

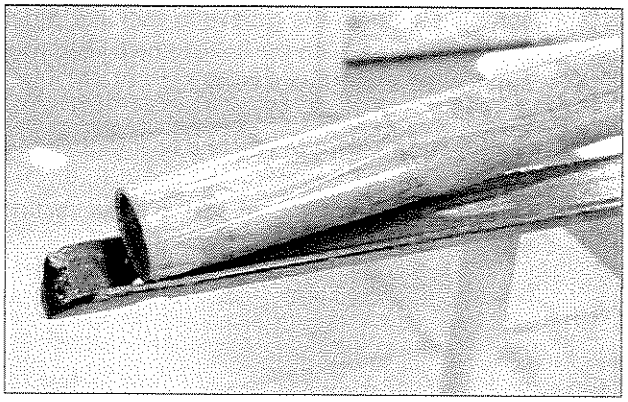


Figure 4.29. Lay the liner in the holder tray.

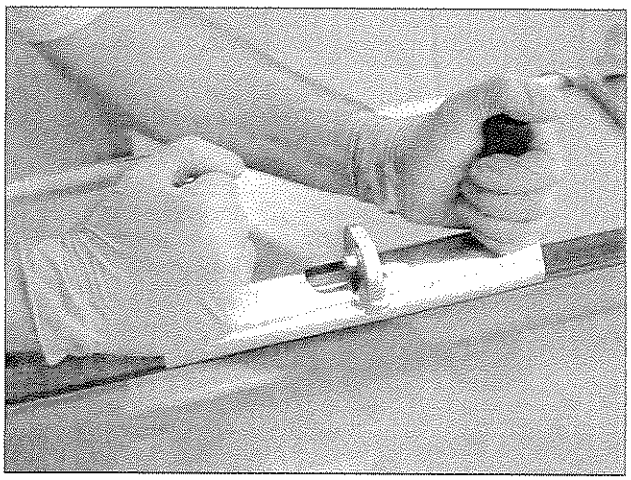


Figure 4.30. Place the grooving tool on top of the liner with the cutting insert positioned approximately 0.25 inches (6 mm) in from the end.

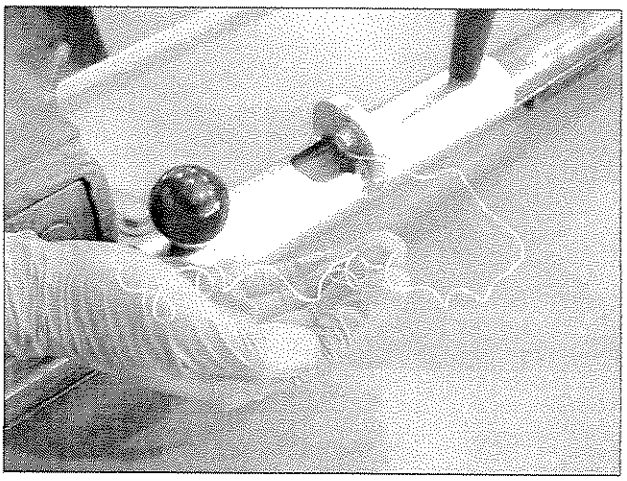


Figure 4.31. A thin ribbon of material will be cut as the tool is drawn down the length of the liner.

Cutting the Liner Open

Once the liner is grooved with the DT21 Grooving Tool, the groove is cut using a utility knife. **Make sure no one is standing near you before starting this procedure!**

1. Holding the utility knife perpendicular to the liner, place the blade in the groove to be cut (Fig. 4.32).

2. Push the blade into the groove by pushing straight down on the knife. Push down until the blade is completely through the liner wall.

3. With the knife blade still in the liner, rotate the knife approximately 90° until the blade is almost tangent to the liner (Fig. 4.33).

4. Grasp the knife such that it is held with the palm of the hand facing up as shown in Figure 4.33.

5. Place your other hand on the liner for support (Fig. 4.33). Make sure the knife blade faces away from this hand to avoid injury should the knife slip out of the liner while cutting.

6. Stand close to the liner holder to keep the hand with the utility knife close to your body for maximum control. Carefully pull the knife completely down the groove in the liner. Move your entire body with the knife to help keep your arm tucked against your body.

7. Repeat Steps 1-6 for the second liner groove.

8. Once both grooves are cut, pull the liner section away to access the soil sample (Fig. 4.34).

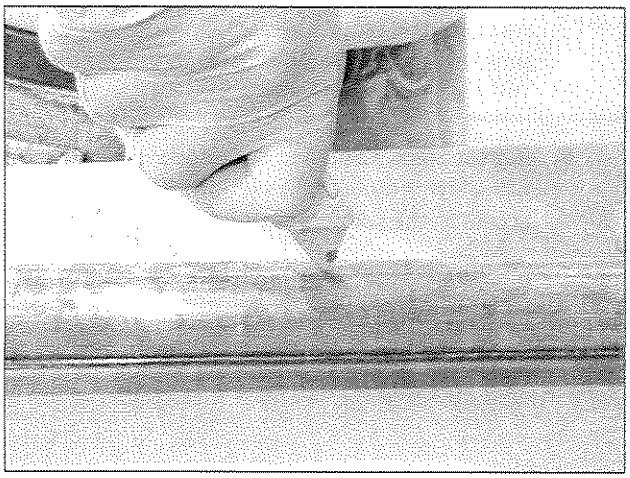


Figure 4.32. Insert the knife blade straight down into the

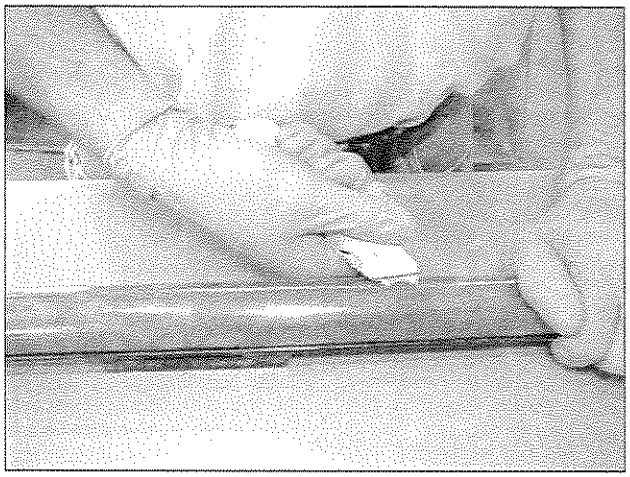


Figure 4.33. Rotate the knife until it is almost tangent to the liner. Gripping the knife palm up and keeping your arm close to your body for control, pull the knife along the groove.

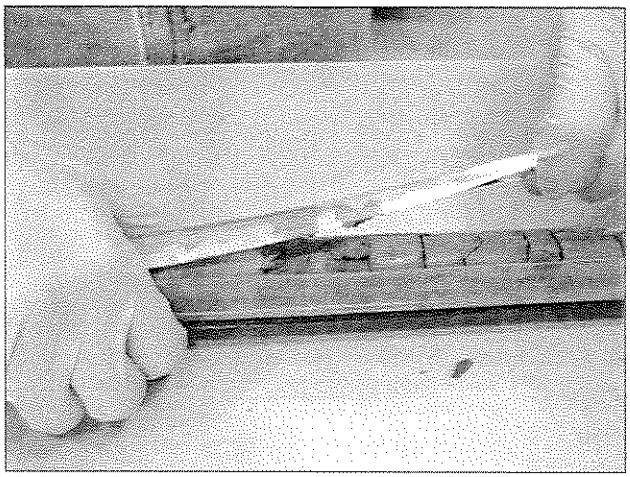


Figure 4.34. After cutting along the two grooves, peel away the liner section to access the soil sample.

4.8 Dual Tube Soil Sampling Tips

Saturated sands are the most difficult formations to sample with the DT22 system. Saturated conditions place positive pressure on the soil outside of the outer casing. When sampling in noncohesive formations (e.g. sands) below the water table, it may be necessary to add water to the outer casing to prevent formation heave. Adding water to the probe rods puts a positive head on the system and may keep formation material from flowing into the rods as the liner and soil sample are retracted. If a small amount of formation material is still drawn into the outer casing as the soil core is retrieved, the material may be displaced by slightly raising the outer casing while lowering the next new liner to depth. Water must be maintained within the outer casing during this process to overcome the hydraulic head imparted by the formation fluid.

DT21 core catcher liners will provide the best sample recovery in saturated noncohesive formations.

DT21 core catcher liners will help considerably with sample recovery in noncohesive soils and other materials that do not fill the liner diameter. Core catcher liners are not recommended for cohesive or expansive soils as the core catchers may actually inhibit soil movement into the liner.

Some clay materials will expand during sampling. Under these conditions, using a shorter sample interval (24-inch liners) may improve sample recovery by minimizing the wall friction as the material is sampled.

4.9 Outer Casing Retrieval

The outer casing of the DT22 Dual Tube System may be retrieved in one of three ways:

1. Casing pulled then probe hole sealed from ground surface with granular bentonite.

   The outer casing may be pulled from the ground with the probe machine and a Pull Cap (25298) or a Rod Grip Pull System (for GH40 Hammers [29461] or for GH60 Hammers [29385]) if the probe hole is to be sealed with granular bentonite from the ground surface (Fig. 4.35). This method is used for shallow probe holes in stable formations only. Such conditions allow the entire probe hole to be sealed with granular bentonite.

2. Casing pulled with probe hole sealed from bottom-up during retrieval.

   Bottom-up grouting should be performed during casing retrieval in unstable formations where side slough is probable. Such conditions create void spaces in the probe hole if granular bentonite is installed from the ground surface.

   A GS500 or GS1000 Grout Machine is used to deliver a sealing material (high-solids bentonite slurry or neat cement grout) to the bottom of the outer casing through flexible tubing. The grout mix is pumped through the tubing to seal the void remaining as the outer casing is retrieved (Fig. 4.36). This is an advantage of the DT22 Dual Tube System as other soil samplers require a second set of tools to deliver grout to the bottom of the probe hole. Contact Geoprobe Systems® for more

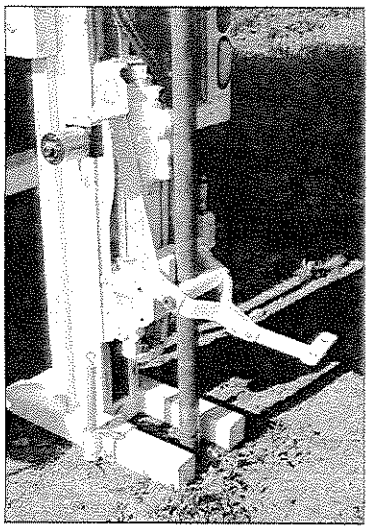


Figure 4.35 Outer casing may be retrieved with a pull cap or rod grip pull system if the probe hole is sealed with granular bentonite.

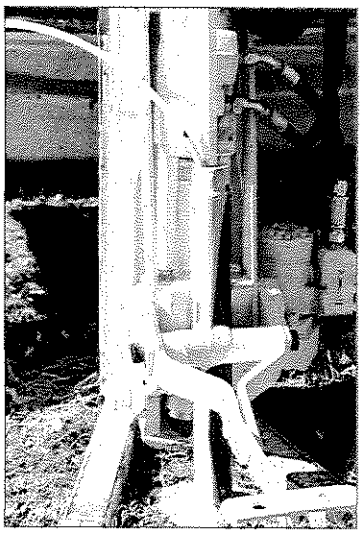


Figure 4.36. A grout machine and flexible tubing allow bottom-up grouting as the outer casing is retrieved.

information on bottom-up grouting with the GS500 and GS1000 Grout Machines.

3. Casing pulled with Geoprobe Prepacked Screen Well installed during retrieval.

   The final option is to install a 1.4-inch OD Geoprobe® Prepacked Screen Monitoring Well in the probe hole during retrieval of the outer casing. A DT22 Expendable Cutting Shoe Holder (29402) and a DT21 Expendable Cutting Shoe (DT4045) allow the operator to collect continuous soil cores as the outer casing is driven to depth. When sampling is complete, the outer rods are raised and the expendable cutting shoe is removed from the leading rod. This leaves an open casing through which a set of prepacked screens is lowered on the leading end of a PVC riser string (Fig. 4.37). The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

   Refer to *Geoprobe® 0.5-in.x 1.4-in. OD and 0.75-in.x 1.4-in. OD Prepacked Screen Monitoring Wells Standard Operating Procedure* (Geoprobe® Technical Bulletin No. 962000) for specific information on well installation.

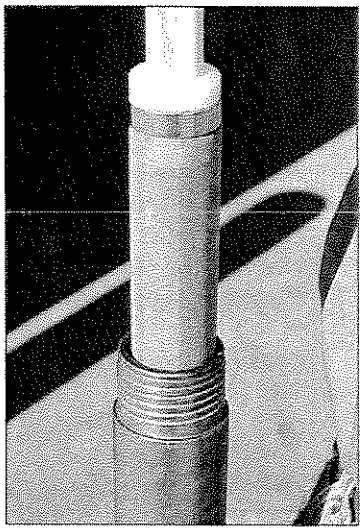


Figure 4.37. Geoprobe® prepacked screens may be installed through the outer casing when an expendable cutting shoe is used.

5.0 REFERENCES

Geoprobe Systems®, *Dual Tube (DT21) Soil Sampling System - Standard Operating Procedure.* Technical Bulletin No. 982100, 2003.

Geoprobe Systems®, *Dual Tube (DT21) Groundwater Profiler Kit - Installation and Operation Instructions.* Instructional Bulletin No. 19275, 2001.

Geoprobe Systems®, *Geoprobe® 0.5-in. x 1.4-in. OD and 0.75-in. x 1.4-in. OD Prepacked Screen Monitoring Wells - Standard Operating Procedure.* Technical Bulletin No. 962000, 2002.

Geoprobe Systems®, *Geoprobe Systems® Tools Catalog,* Vol. 6, 2003.

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe® Systems.

Geoprobe Systems®

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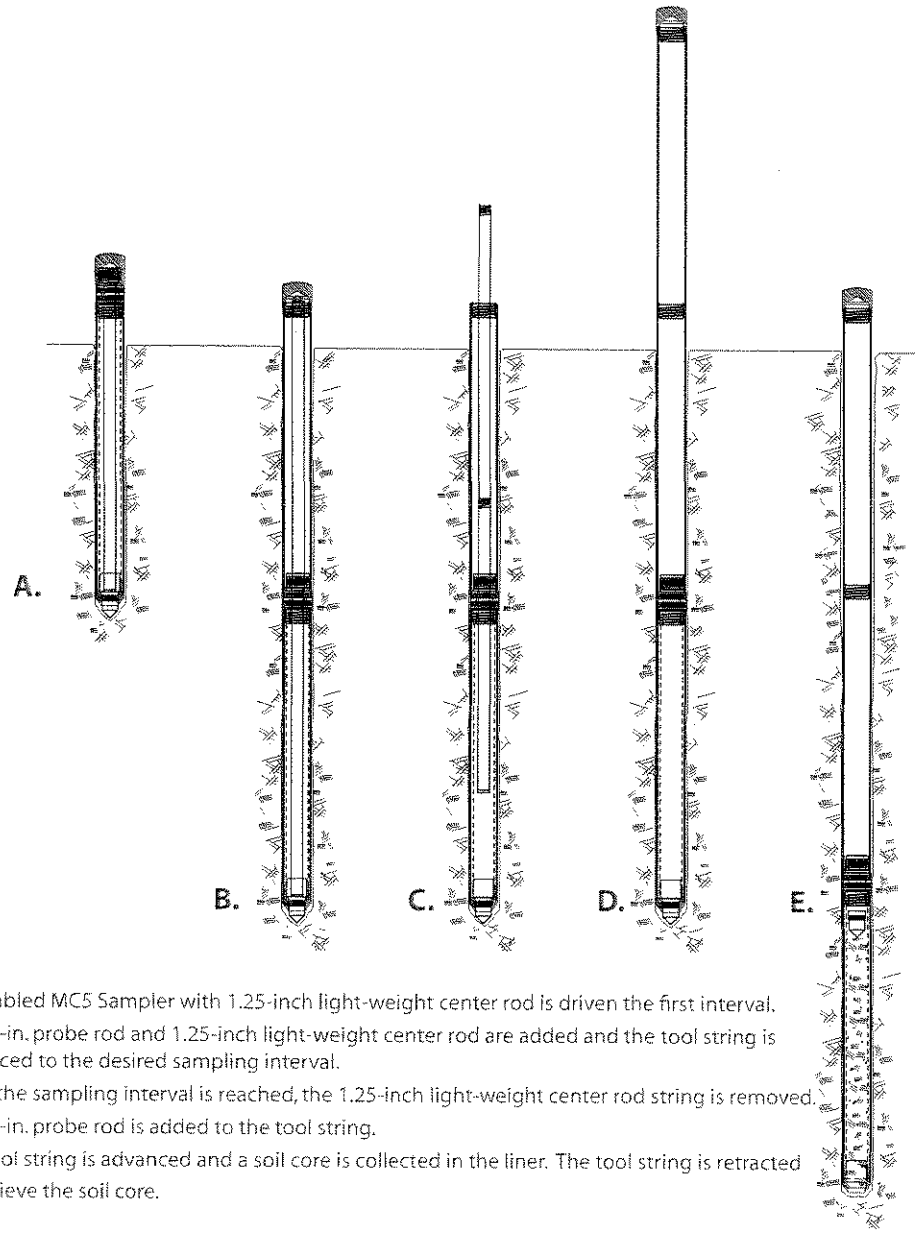
Corporate Headquarters
601 N. Broadway • Salina, Kansas 67401
1-800-GEOPROBE (1-800-436-7762) • Fax (785) 825-2097
www.geoprobe.com

GEOPROBE® MACRO-CORE® MC5
1.25-INCH LIGHT-WEIGHT CENTER ROD SOIL SAMPLING SYSTEM

STANDARD OPERATING PROCEDURE

Technical Bulletin No. MK3139

PREPARED: November, 2006



A. Assembled MC5 Sampler with 1.25-inch light-weight center rod is driven the first interval.
B. A 2.25-in. probe rod and 1.25-inch light-weight center rod are added and the tool string is advanced to the desired sampling interval.
C. Once the sampling interval is reached, the 1.25-inch light-weight center rod string is removed.
D. A 2.25-in. probe rod is added to the tool string.
E. The tool string is advanced and a soil core is collected in the liner. The tool string is retracted to retrieve the soil core.

OPERATION OF THE MACRO-CORE® MC5 SOIL SAMPLING SYSTEM

Geoprobe Systems®

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Macro-Core® and Large Bore Soil Samplers manufactured under US Patent 5,606,139.

Macro-Core® Closed-Piston Drive Point manufactured under US Patent 5,542,481

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1.0 OBJECTIVE

The objective of this procedure is to collect a representative soil sample at depth and recover it for visual inspection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe®*: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling and testing, soil conductivity and contaminant logging, grouting, and materials injection.

**Geoprobe® and Geoprobe Systems® are registered trademarks of Kejr, Inc., Salina, Kansas.*

Macro-Core® MC5 Soil Sampler:** A solid barrel, direct push device for collecting continuous core samples of unconsolidated materials at depth. Although other lengths are available, the standard Macro-Core® MC5 Sample Tubes come in lengths of 48 inches and 60 inches with an outside diameter of 2.25 inches. Samples are collected inside a removable liner. The Macro-Core® MC5 Sampler may be used in an open-tube or closed-point configuration.

***Macro-Core® is a registered trademarks of Kejr, Inc., Salina, Kansas.*

Liner: A removable/replaceable, thin-walled tube inserted inside the Macro-Core® MC5 sample tube for the purpose of containing and storing soil samples. While other lengths are available, the most common Macro-Core® MC5 Liners are 48 inches and 60 inches in length. The liner length should correspond to the length of the sample tube used. Liner materials include stainless steel, Teflon®, and PVC.

1.25-inch Light-Weight Center Rods: Used as the inner Rod String for Macro-Core® MC5 sampling. 1.25-inch Light-Weight Center rods come in lengths of 48 inches and 60 inches. They provide a weight reduction of up to 64% over standard 1.25-inch probe rods.

2.2 Discussion

In this procedure, an assembled Macro-Core® MC5 Soil Sampler is driven one sampling interval into the subsurface and retrieved using a Geoprobe® direct push machine. The collected soil core is removed from the sampler along with the used liner. After decon, the Macro-Core® sampler is reassembled using a new liner. The clean sampler is then advanced back down the same hole to collect the next soil core. The Macro-Core® Sampler may be used as an open-tube or closed-point sampler.

The Macro-Core® MC5 Soil Sampler is commonly used as an open-tube sampler (Fig. 2.1A). In this configuration, coring starts at the ground surface with a sampler that is open at the leading end. The sampler is driven into the subsurface and then pulled from the ground to retrieve the first soil core. In stable soils, an open-tube sampler is advanced back down the same hold to collect the next core.

In unstable soils which tend to collapse into the core hold, the Macro-Core® MC5 Sampler can be equipped with a 1.25-inch Center Rod Closed-Point assembly (Fig 2.1B). The point fits firmly into the cutting shoe and is held in place by the 1.25-inch light-weight center rods. The Macro-Core® MC5 Center Rod System prevents collapsed soil from entering the sampler as it is advanced to the bottom of an existing hole, thus ensuring collection of a representative sample. Once the 1.25-inch light weight center rod system is removed, the point

will be pushed up the liner during the next sampling interval. The point assembly is later retrieved from the sampler with the liner and soil core.

The Macro-Core® MC5 Soil Sampler is a true discrete sampler. It can be driven through undisturbed soil to a desired depth using the 1.25-inch Light Weight Center Rod System. Once the 1.25-inch light-weight center rods are removed, a representative sample is recovered from the desired depth.

Loose soils may fall from the bottom of the sampler as it is retrieved from depth. The MC Core Catcher (Fig. 3.1) alleviates this problem. Excellent results are obtained when the core catcher is used with saturated sands and other non-cohesive soils. A core catcher should not be used with tight soils as it may actually inhibit sample recovery. In that case, a MC Spacer Ring or extended shank cutting shoe can be used. Constructed of PVC, the core catcher is suitable for use with all Geoprobe® liners.

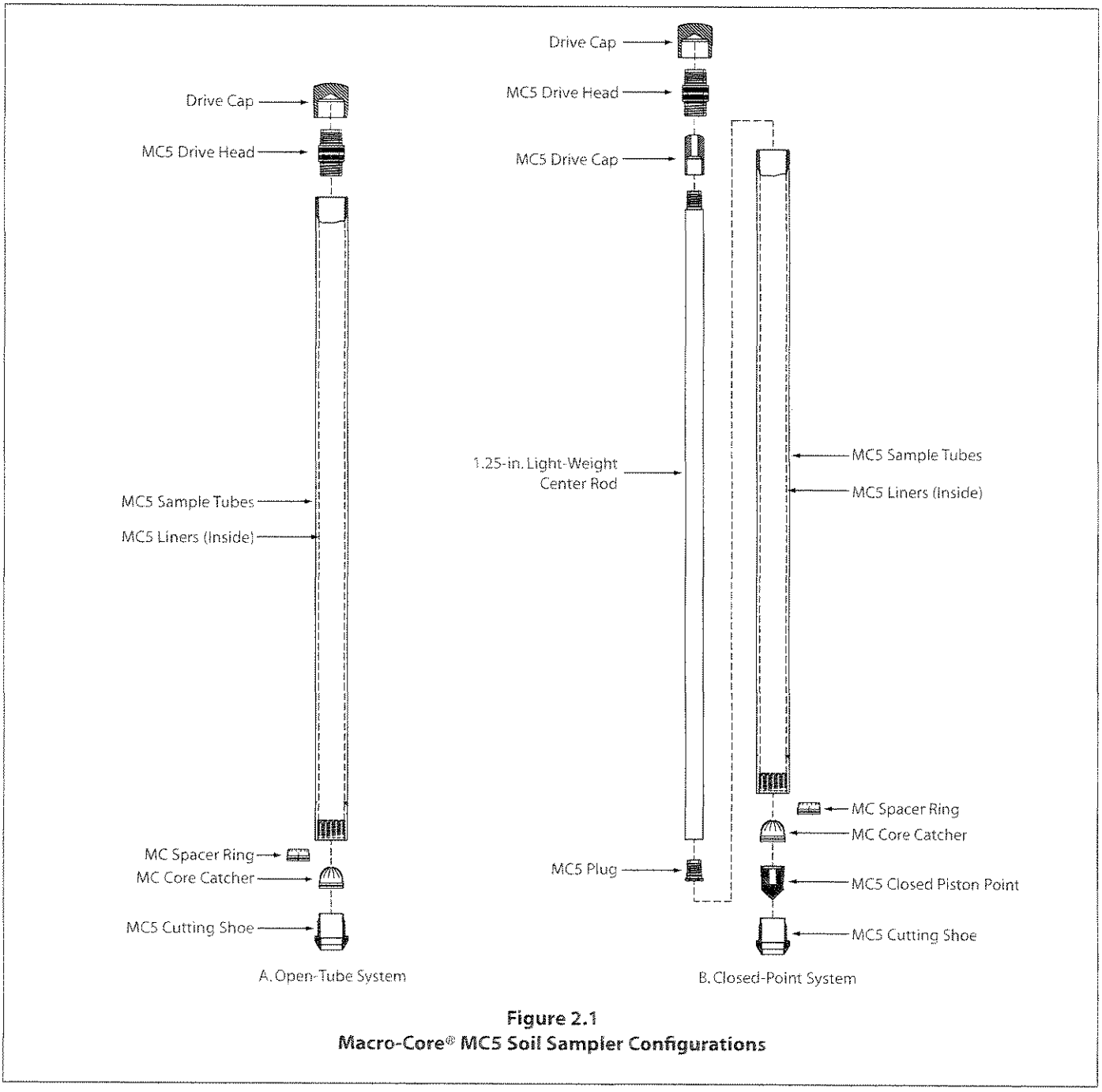


Figure 2.1
Macro-Core® MC5 Soil Sampler Configurations

3.0 TOOLS AND EQUIPMENT

The following tools and equipment can be used to recover representative soil cores with the MC5 Soil Sampling System. Sample tubes, 1.25-inch light-weight center rods, probe rods, and liners all need to be of equal length in order to obtain a sample. Refer to Figure 3.1 for identification of the specified parts. Additional tooling options are available in Appendix A.

MC5 Sampler Parts	Part Number
MC5 Drive Head, 2.25 in. bored	28646
MC5 Drive Head, 2.125 in. bored	23640
MC5 Sample Tubes, 60 in	22992
MC5 Sample Tubes, 48 in	22923
MC5 Sample Tubes, 1 m	24239
MC5 Sample Tubes, 36 in	24238
MC5 Sample Tubes, 24 in	24237
MC5 Cutting Shoe, standard, 2.25 in. OD	22922
MC5 Cutting Shoe, undersized, 1.35 in. ID	23957
MC5 Cutting Shoe, standard, 2.25 in. OD (extended shank)	23978
MC5 Cutting Shoe, undersized, 1.35 in. ID (extended shank)	28237
MC5 Cutting Shoe, undersized, 1.25 in. ID (extended shank)	26078
MC5 Cutting Shoe, Heavy Duty, 1.35 in. ID,	29552
MC5 Closed Piston Point, standard	28113
MC5 Closed Piston Point, undersized	26865

Center Rods (1.25 in.) and Center Rod Accessories	Part Number
1.25-in. Center Rod, 60 in. Lightweight	27600
1.25-in. Center Rod, 48 in. Lightweight	21900
Probe Rod, 1.25 in. x 1 m	AT1239
Probe Rod, 1.25 in. x 36 in	AT1236
Probe Rod, 1.25 in. x 24 in	AT1224
MC5 Drive Cap, 1.25 in. Center Rod, Threadless	23639
MC5 Plug Threaded, 1.25 in.	23641
1.25 in. Pull Cap	AT1204

	Part Numbers for Specific Probe Rod OD	
Probe Rods and Probe Rod Accessories	2.25-in. OD	2.125-in. OD
Probe Rod, 60 in.	25301	AT2160
Probe Rod, 48 in.	25300	AT2148
Probe Rod, 1 m.	25352	AT2139
Probe Rod, 2.125 in. x 36 in.		AT2136
Probe Rod, 2.125 in. x 24 in.		13072
Drive Cap, GH60 Series, Threadless	31530	8397
Drive Cap, GH40 Series, Threadless	31405	
Drive Cap, GH40 Series, Threaded		AT2101
Pull Cap	25298	AT2104

MC5 Liners, Accessories, and Miscellaneous Tools	Part Number
MC Liners, 60 in. (66 liners)	10074
MC Liners, 48 in. (66 liners)	AT927K
MC Liners, 1m. (66 liners)	AT928K
MC Liners, 36 in. (66 liners)	AT921K
MC Liners, 24 in. (66 liners)	AT926K
MC Core Catcher	AT8531
MC Spacer Ring	AT8532
MC Spacer Ring (Bulk Box of 500)	AT8533K
Vinyl End Caps (Package of 66)	AT726K
Liner Cutter	AT8010
Universal Liner Holder	22734
Rod Wiper Weldment	23633
Rod Wiper Doughnuts, 2.125-in and 2.25-in.	26876
Two Pipe Wrenches	

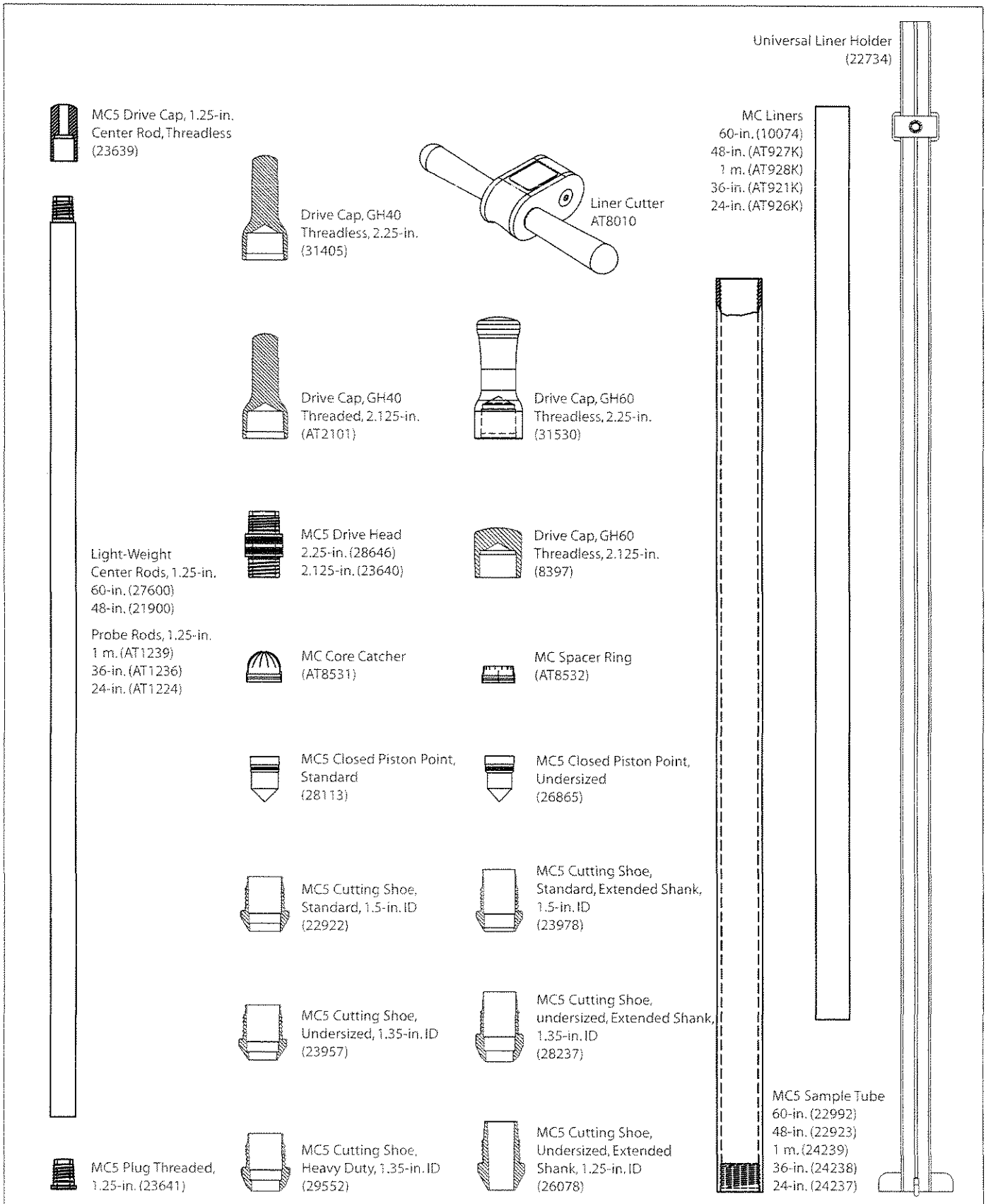


Figure 3.1
Macro-Core® MC5 Soil Sampler Parts

3.1 Tool Options

Five major components of the MC5 Soil Sampling System are sample tubes, probe rods, 1.25-inch light-weight center rods, sample liners, and cutting shoes. These items are manufactured in a variety of sizes to fit the specific needs of the operator. This section identifies the specific tool options available for use with the MC5 Soil Sampling System.

Sample Tubes
MC5 Sample tubes come in lengths of 60 inches (1524 mm), 48 inches (1219 mm), 1 meter, 36 inches (914 mm), and 24 inches (610 mm).

Probe Rods
Standard Geoprobe® 2.125-inch and 2.25-inch OD probe rods are required to operate the MC5 Soil Sampling System. The specific length of rods may be selected by the operator. The most common rod lengths used in MC5 Soil Sampling are the 60-inch and 48-inch rods.

1.25-inch Light-Weight Center Rods
1.25-inch Light-Weight Center Rods (1.25-inch / 32-mm OD) are recommended for the inner rod string of the MC5 system when utilizing an outer casing of 48- or 60-inch long rods. Choose the light-weight rod length that matches the length of rods used for the outer casing (48-inch light-weight rods with 48-inch outer casing, etc.). Currently, standard Geoprobe® 1.25-inch probe rods must be used with 24-inch, 36-inch, and 1-meter MC5 Sample Tubes.

A weight reduction of up to 64% is provided by the 1.25-inch Light-Weight Center Rods over standard 1.25-inch probe rods. As a result, considerably less energy is expended when retrieving the 1.25-inch Light-Weight Center Rods from within the outer casing during operation of the MC5 System.

Sample Liners
Sample liners are made of heavy-duty clear plastic for convenient inspection of the soil sample. Nominal lengths of 24 inches, 36 inches, 1 meter, 48 inches, and 60 inches are available. Choose the liner length corresponding to the length of the sample tube used (e.g. 60-inch liners with 60-inch sample tubes).

Cutting Shoes
Six cutting shoes are available for use with the MC5 Soil Sampling System (Fig. 3.2). The extended shank cutting shoes (23978, 28237, and 26078) fit inside the sample liner and help soil pass freely into the liner. The other three cutting shoes (22922, 23957, 29552) require an MC Core Catcher (AT8531) or MC Spacer Ring (AT8532) in order to properly connect to the sample liners.

The most prominently used cutting shoes are the two "standard" cutting shoes (22922 and 23978). These cutting shoes collect a 1.5-inch (38-mm) diameter soil core.

Undersized cuttings shoes (23957, 28237, and 29552) collect a smaller 1.35-inch (34-mm) soil core and are used in formations with plastic clays or other soil types that lead to overfilling of the sampler liner. Of these, the 29552 and 28237 cutting shoes are also thicker at the leading end for increased durability in harsh conditions where cobbles or large gravel are present.

Soil formations with highly plastic clays may call for an even smaller soil core. In these conditions, a 26078 cutting shoe with its 1.25-inch (32-mm) soil core is most effective.

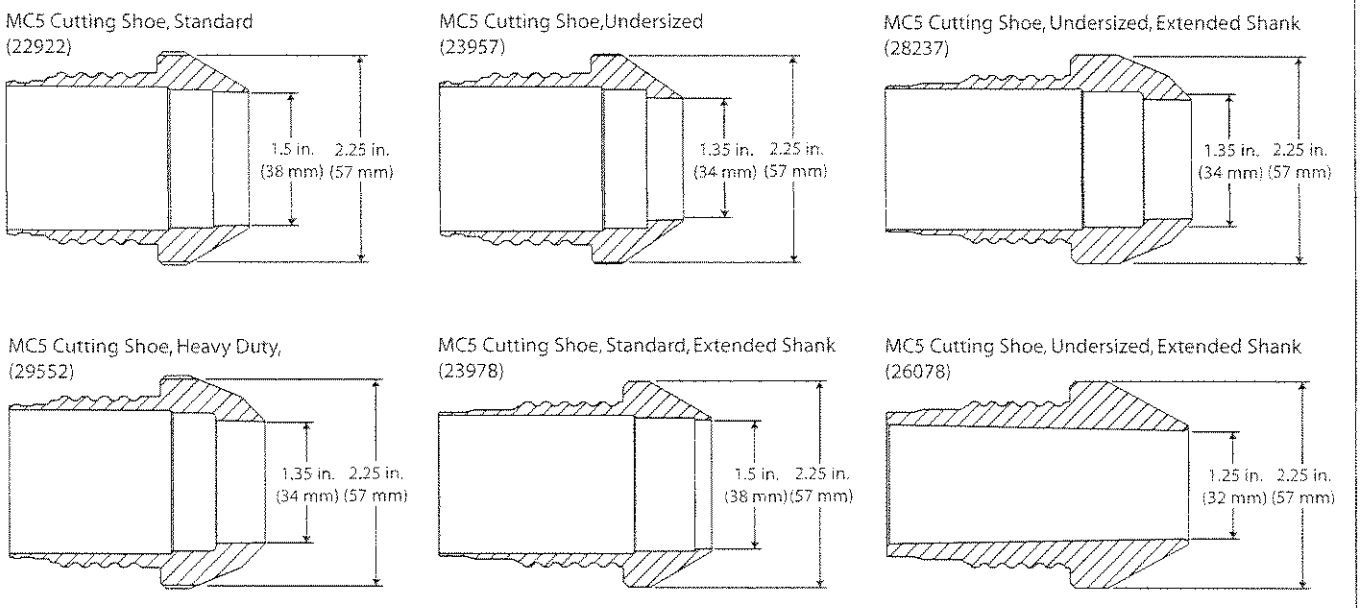


Figure 3.2
Cutting Shoe Options for Macro-Core® MC5 Soil Sampler

4.0 OPERATION

All parts shown in illustrations are those most commonly used configuration for the MC5 Sampling System. Refer to Section 3.0 for part numbers and additional tooling options.

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the soil sampling system according to project requirements. Parts should be inspected for wear or damage at this time. During sampling, a clean new liner is used for each soil core.

Cleaning inside the probe rods and MC5 sample tubes is accomplished with the nylon brushes and extension rods listed in Appendix A. Thread a nylon brush and handle onto an extension rod of suitable length. Using clean water and phosphate-free soap, cycle the brush inside the probe rod or sample tube to remove contaminants. Rinse with clean water and allow to air dry.

4.2 Field Blank

It is suggested that a field blank be taken on a representative sample liner prior to starting a project and at regular intervals during extended projects. Liners can become contaminated in storage. A field blank will prove that the liners do not carry contaminates which can be transferred to soil samples. The following information is offered as an example method which may be used to take a field blank. Make the appropriate modifications for the specific analytes of interest to the investigation.

Example Procedure Required Equipment

MC Liner ..... (1)
MC Vinyl End Caps ..... (2)
Distilled Water ..... (100 ml)
VOA Vial (or other appropriate sample container) ..... (1)

1. Place a vinyl end cap on one end of the liner.
2. Pour 100 milliliters of distilled water (or other suitable extracting fluid) into the liner.
3. Place a vinyl end cap on the open end of the liner.
4. From the vertical position, repeatedly invert the liner so that the distilled water contacts the entire inner surface. Repeat this step for one minute.
5. Remove one end cap from the liner, empty contents into an appropriate sample container, and cap the container.
6. Perform analysis on the extract water for the analytes of interest to the investigation.

4.3 Open-Tube Sampler Assembly

1a. Using the MC Core Catcher

Place the open end of an MC Core Catcher over the threaded end of an MC5 Cutting Shoe (22992, 23957, 29552) as shown in Figure 4.2. Apply pressure to the core catcher until it snaps into the machined groove on the cutting shoe. The core catcher should be used in loose soils, especially saturated sands (non-cohesive soils). Use of the core catcher is not necessary in tough, cohesive soils or tight clays, and may interfere with sampling especially in soft clays. The "fingers" of the core catcher flex outward to let soil move into the liner while sampling.

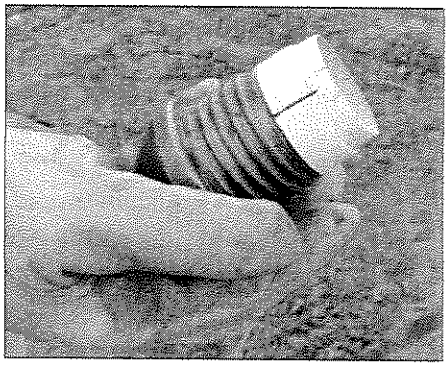
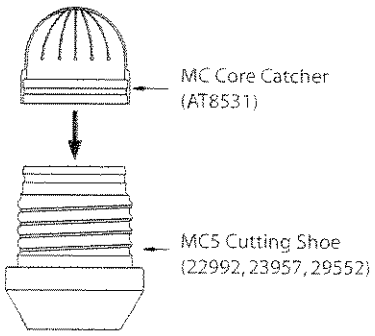


Figure 4.1. The spacer ring fits securely onto the MC5 Cutting Shoe.

1b. Using the MC Spacer Ring



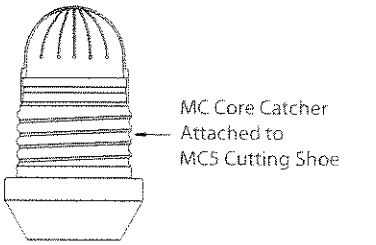
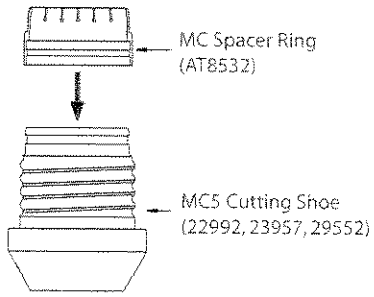


Figure 4.2
Core Catcher Attachment



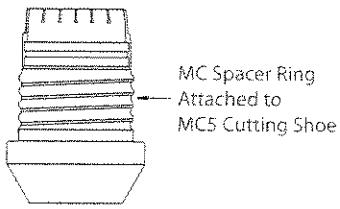
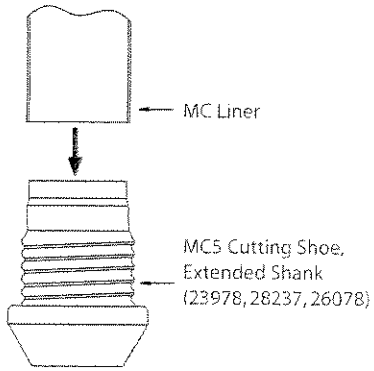


Figure 4.3
Spacer Ring Attachment



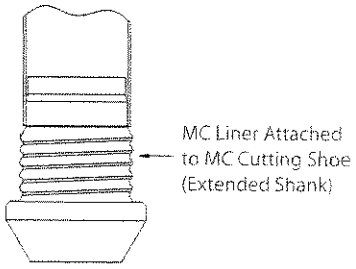


Figure 4.4
Liner Attachment on Extended Shank

Push the base of an MC Spacer Ring onto the threaded end of an MC5 Cutting Shoe (22992, 23957, 29552) until it snaps into the machined groove on the cutting shoe (Fig. 4.1 and Fig. 4.3). Spacer rings should be used when sampling cohesive soils. It allows soil to pass freely over the junction between the liner and cutting shoe.

1c. Using the Extended Shank Cutting Shoe

The cutting shoes with extended shanks (23978, 28237, 26078) do not use core catchers or spacer rings. MC5 Liners should securely slide onto the end of these cutting shoes (Fig. 4.4). The extended shank cutting shoes should only be used when sampling cohesive soils. When sampling loose soils, especially saturated sands (non-cohesive soils), a cutting shoe with an MC Core Catcher is recommended.

2. Place either end of the liner onto the spacer ring or core catcher (Fig. 4.6). If you are using a cutting shoe with an extended shank, do not use a spacer ring or core catcher (Fig. 4.7). The liner should fit securely onto the spacer ring, core catcher, or cutting shoe.

3. Slide whole assembly into either end of the sample tube (Fig. 4.8). Thread the cutting shoe onto the sample tube (Fig. 4.9). If the thread is clean, it should easily thread on by hand. In some cases, a wrench may be necessary for tightening. There shouldn't be a gap between the cutting shoe and sample tube.

4. Thread an MC5 Drive Head into the top of the sample tube (Fig. 4.10). Securely tighten the drive head by hand. Ensure that the end of the sample tube contacts the machined shoulder of the drive head.

Sampler Assembly is Complete

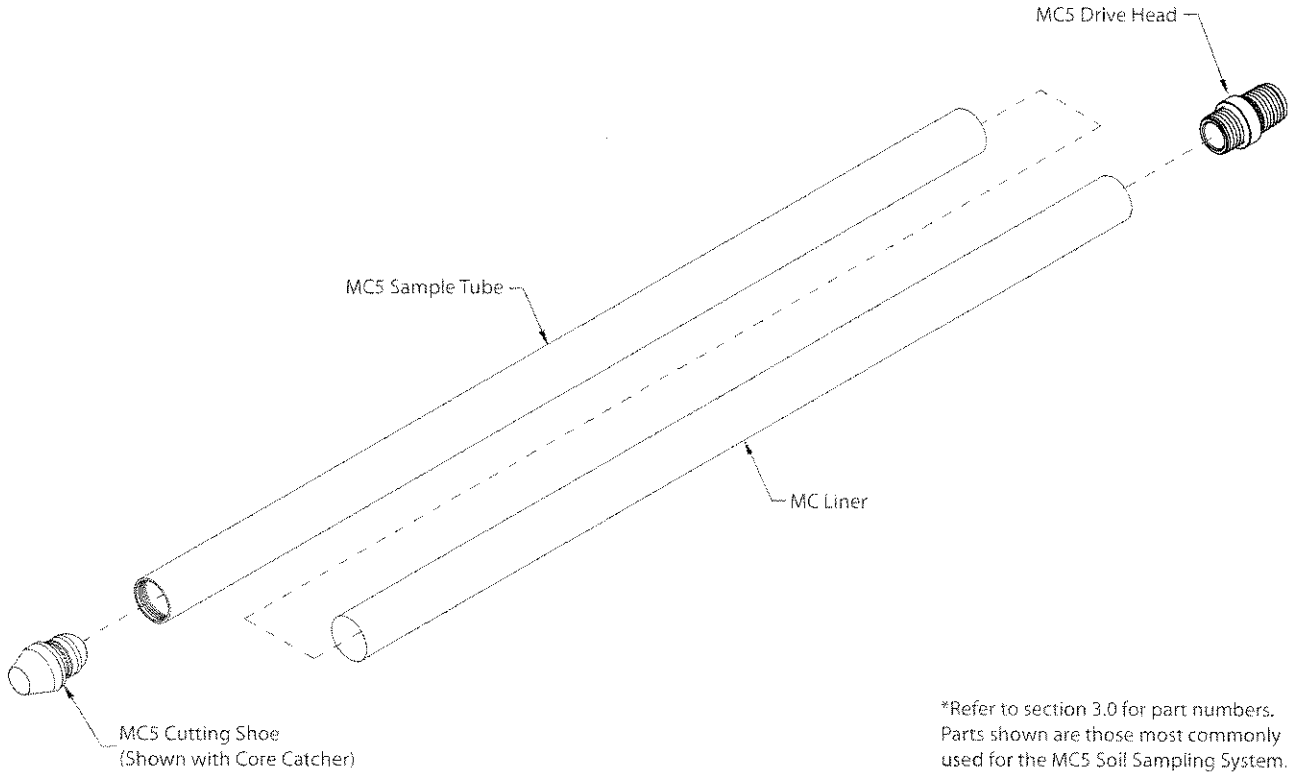


Figure 4.5
MC5 Open-Tube Sampler Assembly

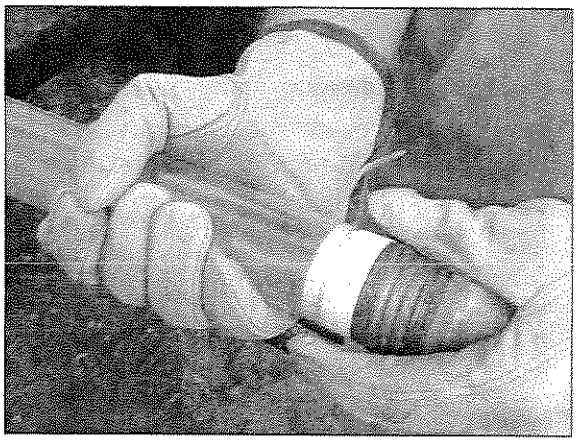


Figure 4.6. Place either end of the liner onto the spacer ring or core catcher. The liner should fit securely.

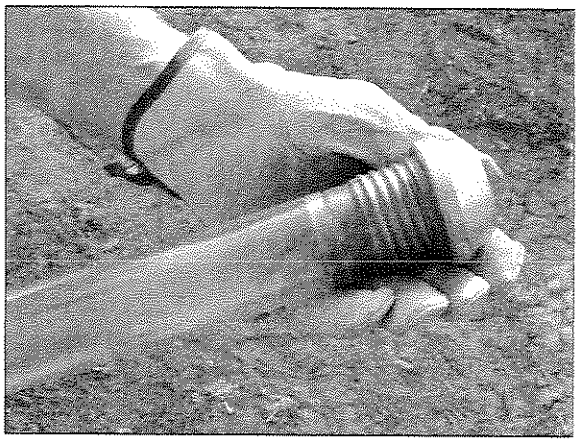


Figure 4.7. Place either end of the liner onto the extended shank cutting shoe. (This is used in place of a spacer ring or core catcher)

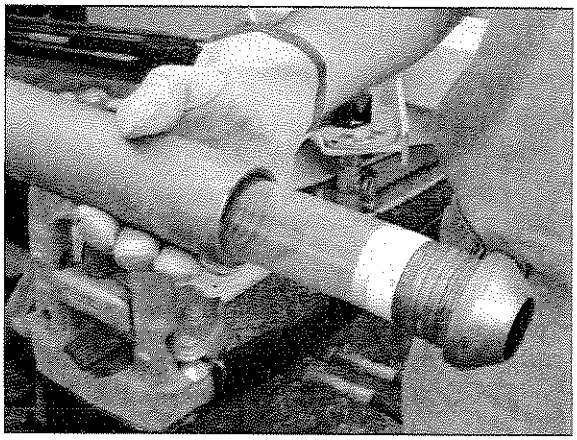


Figure 4.8. Slide whole assembly into either end of the sample tube.

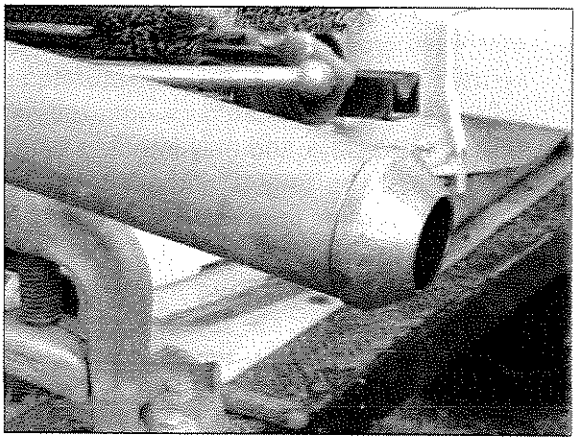


Figure 4.9. Thread the cutting shoe onto the sample tube.

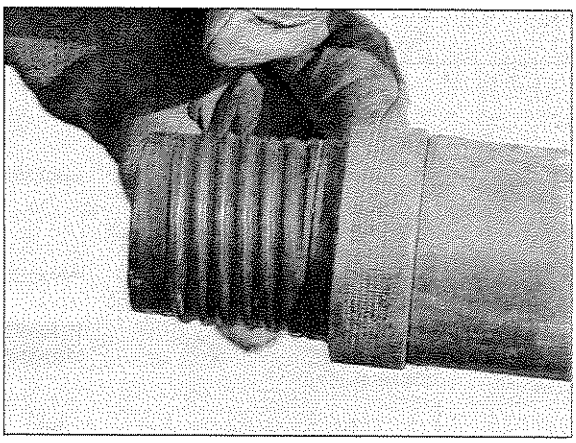


Figure 4.10. Thread the MC5 Drive Head onto the opposite end of the sample tube. Tighten by hand.

4.4 MC5 Closed-Point Sampler Assembly

The Macro-Core® 1.25-inch Light-Weight Center Rod Sampling System seals the leading end of the sampler with a point (Fig. 4.11) assembly that is held in place with a 1.25-inch light weight center rod. Once advanced to the top of the sampling interval, the 1.25-inch Light-Weight Center Rods are removed from the probe rod string.

1. Install an O-ring in the machined groove on the piston rod point (Fig. 4.12).

2. Push the MC5 Closed Piston Point (28113 or 26865) completely into the cutting shoe as shown in Figure 4.12. Note that the standard point (28113) is used with 1.5-inch (38-mm) ID cutting shoes and the undersized point (26865) is for cutting shoes with a 1.35-inch (34-mm) ID.



Figure 4.11. The MC5 Closed Piston Point slides into the cutting shoe.

3a. Using the MC Core Catcher

Place the open end of an MC Core Catcher over the threaded end of an MC5 Cutting Shoe (22992, 23957, 29552) as shown in Figure 4.13. Apply pressure to the core catcher until it snaps into the machined groove on the cutting shoe. The core catcher should be used in loose soils, especially saturated sands (non-cohesive soils). Use of the core catcher is not necessary in tough, cohesive soils or tight clays, and may interfere with sampling especially in soft clays. The "fingers" of the core catcher flex outward to let soil move into the liner while sampling.

3b. Using the MC Spacer Ring

Push the base of an MC Spacer Ring onto the threaded end of an MC5 Cutting Shoe (22992, 23957, 29552) until it snaps into the machined groove on the cutting shoe (Fig. 4.14). Spacer rings should be used when sampling cohesive soils. It allows soil to pass freely over the junction between the liner and cutting shoe.

3c. Using the Extended Shank Cutting Shoe

The cutting shoes with extended shanks (23978, 28237) do not use core catchers or spacer rings. MC5 Liners should securely slide onto the end of these cutting shoes (Fig. 4.15). The extended shank cutting shoes shoud only be used when sampling cohesive soils. When sampling loose soils, especially saturated sands (non-cohesive soils), a cutting shoe with an MC Core Catcher is recommended.

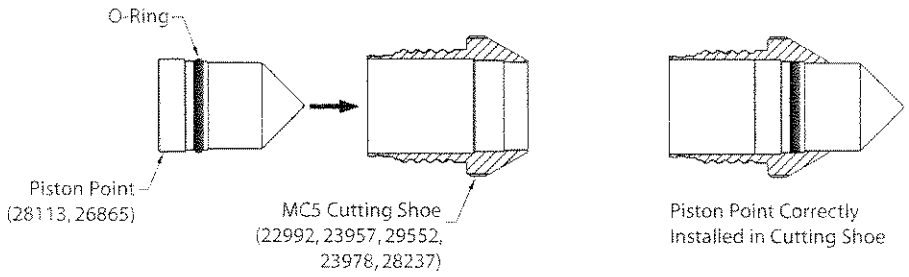


Figure 4.12
Installation of MC5 Closed Piston Point Assembly in MC5 Cutting Shoe

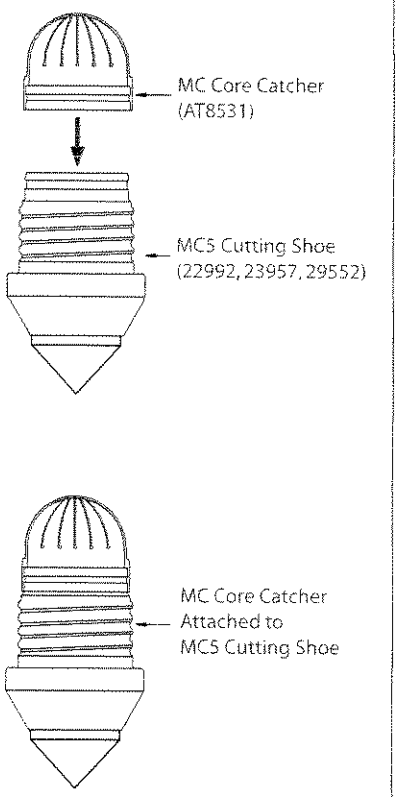


Figure 4.13
Core Catcher Attachment With Point Assembly

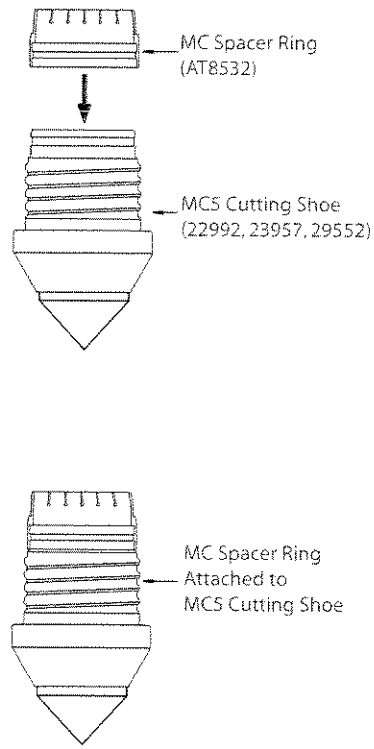


Figure 4.14
Spacer Ring Attachment With Point Assembly

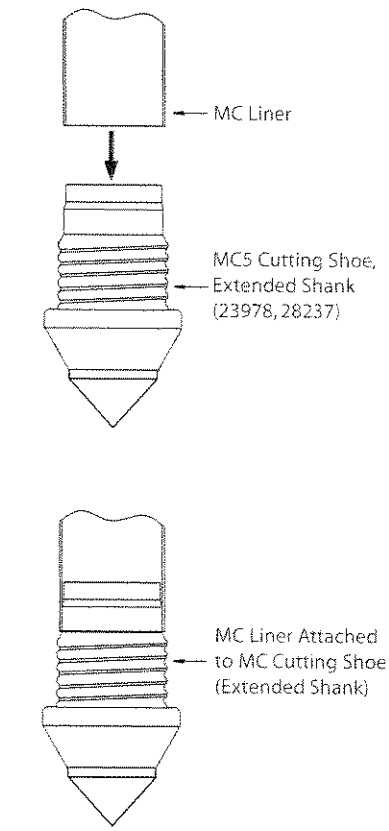


Figure 4.15
Liner Attachment on Extended Shank With Point Assembly

Refer to Figure 4.16 for MC5 Closed-Point Sampler Assembly

4. Place either end of the liner onto the spacer ring or core catcher (Fig. 4.18). If you are using a cutting shoe with an extended shank, do not use a spacer ring or core catcher (Fig. 4.19). The liner should fit securely onto the spacer ring, core catcher, or cutting shoe.

5. Slide whole assembly into either end of the sample tube (Fig. 4.20). Thread the cutting shoe onto the sample tube (Fig. 4.21). If the thread is clean, it should easily thread on by hand. In some cases, a wrench may be necessary for tightening. There shouldn't be a gap between the cutting shoe and sample tube.

6. Thread an MC5 Drive Head into the top of the sample tube. Securely tighten the drive head by hand. Ensure that the end of the sample tube contacts the machined shoulder of the drive head (Refer to Figure 4.10).

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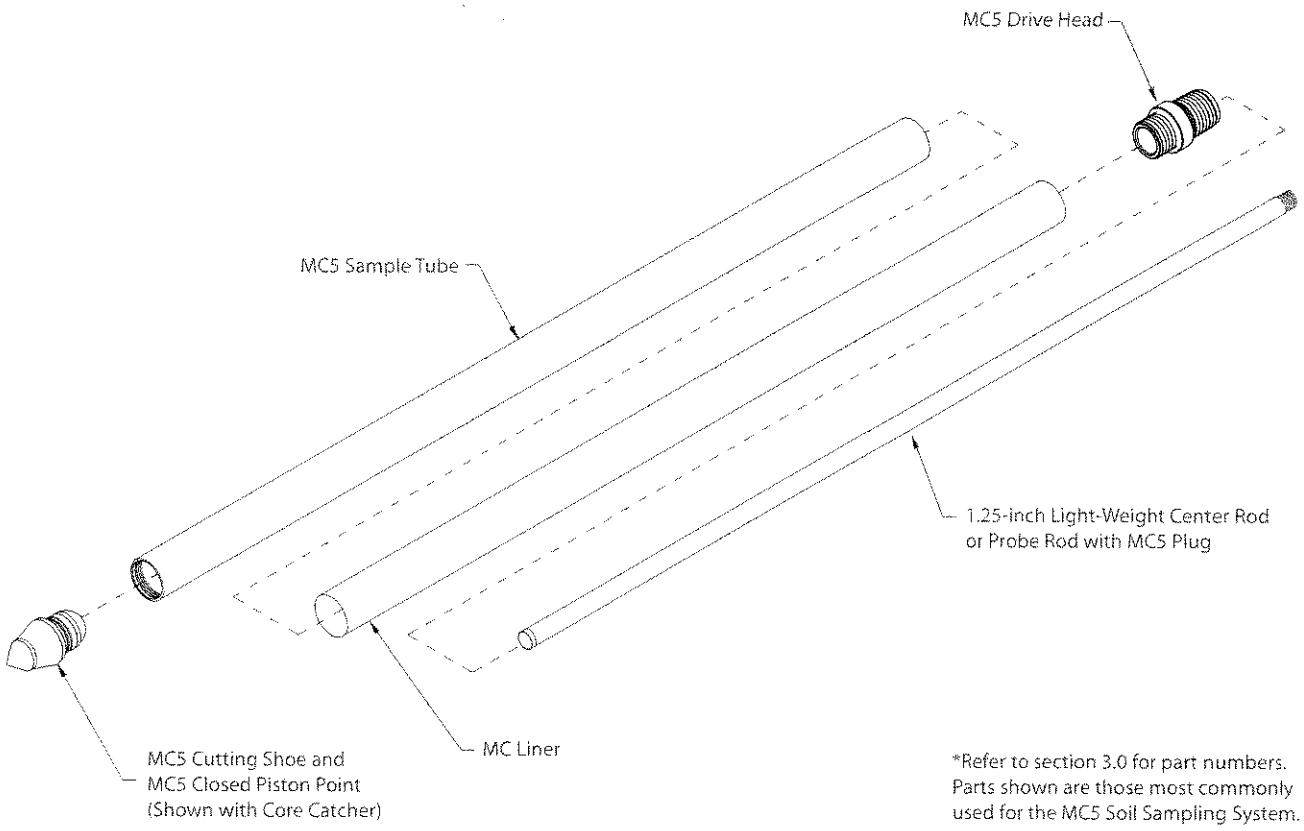


Figure 4.16
MC5 Closed-Point Sampler Assembly

7. Thread an MC5 Plug (23641) onto 1.25-inch light-weight center rod (Fig. 4.22). Note that light-weight center rods are only available in 48-inch and 60-inch lengths. Utilize 1.25-inch probe rods if other lengths are required.

8. Insert the light-weight center rod and MC5 Plug into sample tube assembly (Fig. 4.23), sending the plug end in first. Allow it to come in contact with the top of the Piston Point (Fig. 4.17).

Sampler Assembly is Complete

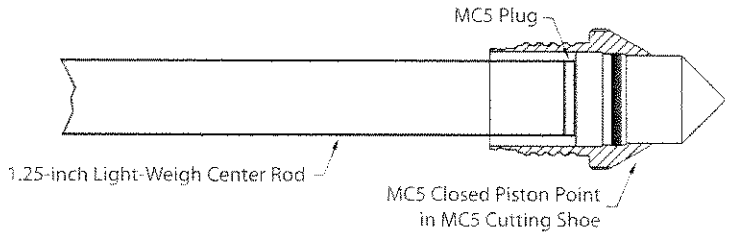


Figure 4.17
MC5 Closed-Point Center Rod Assembly

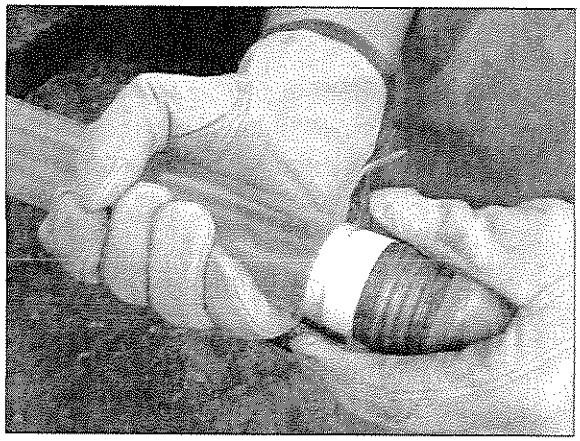


Figure 4.18. Place either end of the liner onto the spacer ring or core catcher. The liner should fit securely.

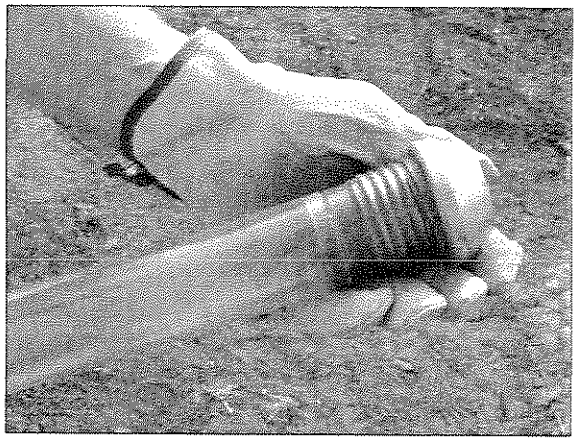


Figure 4.19. Place either end of the liner onto the extended shank cutting shoe. (This is used in place of a spacer ring or core catcher)

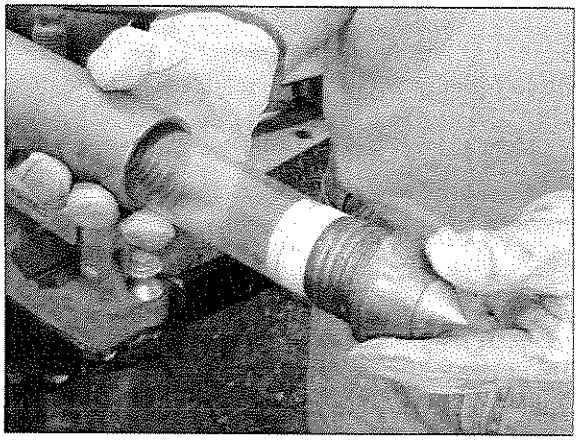


Figure 4.20. Slide whole assembly into either end of the sample tube.

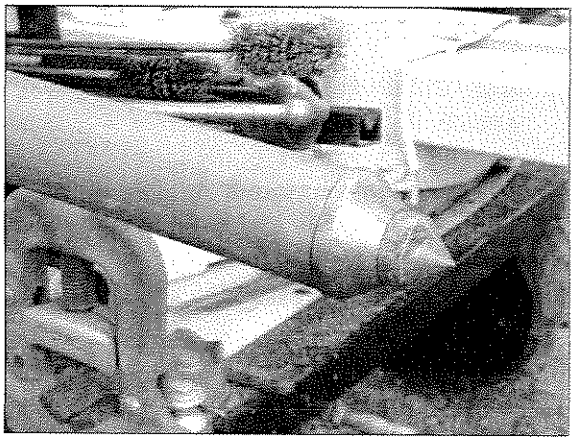


Figure 4.21. Thread the cutting shoe and point onto the sample tube.

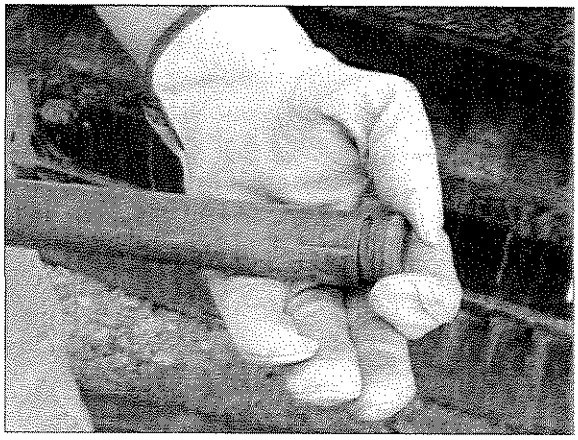


Figure 4.22. The MC5 Plug is threaded onto the end of the 1.25-inch light-weight center rod.



Figure 4.23. The MC5 Plug and a 1.25-inch light-weight center rod are inserted into the sample tube.

4.7 Open-Tube Sampling

The MC5 Open-Tube Sampler is used to gather continuous soil cores beginning from ground surface. A representative soil sample is obtained by driving the assembled sampler one sampling interval into the subsurface through undisturbed soil. Upon retrieving the sampler, the liner and soil core are removed. The sampler is then properly decontaminated, reassembled with a new liner, and inserted back down the same hole to collect the next soil core.

Instructions for operating the MC5 Open-Tube Sampler are given in this section.

1. Place a drive cap onto the drive head (Fig. 4.24) of an assembled Open-Tube Sampler (Refer to Section 4.3 for sampler assembly).

2. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder.

3. Position the MC5 Sampler directly under the hammer with the cutting shoe centered between the toes of the probe foot. The sampler should now be parallel to the probe derrick. Step back from the unit and visually check sampler alignment (Fig. 4.25).

4. Apply static weight and hammer percussion to advance the sampler until the drive head reaches the ground surface. (Fig. 4.27A)

   NOTE: Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.

5. Raise the hammer assembly a few inches to provide access to the top of the sampler.

6. Remove the drive cap and thread a pull cap onto the sampler drive head (Fig. 4.26).

7. Lower the hammer assembly and hook the hammer latch over the pull cap. Raise the hammer assembly to pull the sampler completely out of the ground. If a winch is available, it can be used with a pull plate to retract the tool string. A Rod Grip Pull Handle can also be used to retract the tool string.

8. Proceed to Section 4.9 for instructions on recovering the soil core from the MC5 Sampler.

To sample consecutive soil cores, advance a clean sampler down the previously opened hole (Fig. 4.27B) to the top of the next sampling interval (Fig. 4.27C). Drive the tool string the length of the sampler to collect the next soil core (Fig. 4.27D). Switch to an MC5 Center Rod Sampler if excessive side slough is encountered.

NOTE: Use caution when advancing or retrieving the sampler within an open hole. Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.

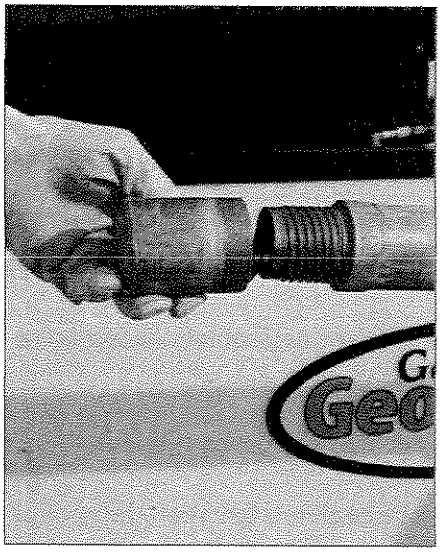


Figure 4.24. Place drive cap onto sampler drive head.

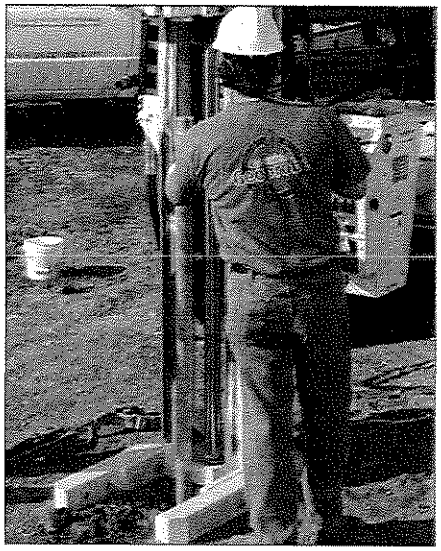


Figure 4.25. The sampler should be parallel to the probe derrick for driving.

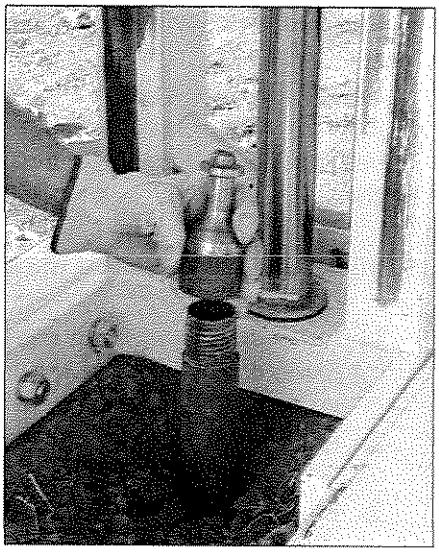
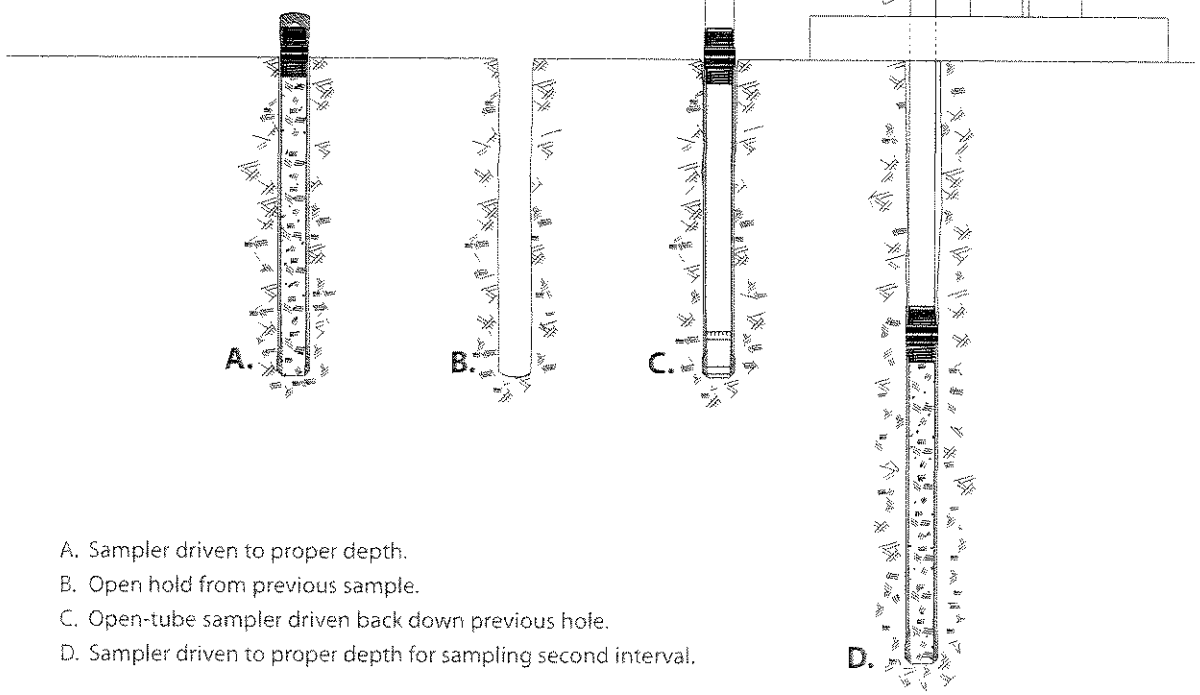


Figure 4.26. The pull cap is one way to remove the sampler from the ground.



A. Sampler driven to proper depth.
B. Open hold from previous sample.
C. Open-tube sampler driven back down previous hole.
D. Sampler driven to proper depth for sampling second interval.

Figure 4.27
Phases of MC5 Open-Tube Soil Sampling

4.8 Closed-Point Sampling with the MC5 Center Rod System

Material collapsing from the probe hole sidewall can make it difficult to collect representative soil cores from significant depths with an open-tube sampler. To overcome this problem, the MC5 Sampler can be equipped with a center rod assembly that will hold the piston point in place. This allows the sealed sampler to pass through the slough material and then it can be opened at the appropriate sampling interval.

Instructions for operating the MC5 Closed-Point Sampler are given in this section.

1. Place a drive cap onto the center rod and a drive cap onto the drive head of an assembled Closed-Point Sampler (Refer to Section 4.4 for sampler assembly).

2. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder.

3. Position the MC5 Sampler directly under the hammer with the cutting shoe centered between the toes of the probe foot. The sampler should now be parallel to the probe derrick. Step back from the unit and visually check sampler alignment (Fig. 4.25).

4. Apply static weight and hammer percussion to advance the sampler until the drive head reaches the ground surface (Fig. 4.28A).

5. Add additional probe rods and 1.25-inch light-weight center rods to the tool string until the desired sampling interval is reached (Fig. 4.28B).

6. Once the sampling interval is reached, remove the center rod string (Fig. 4.28C).

7. Add an additional probe rod to the string and place a drive cap on the probe rod (Fig. 4.28D).

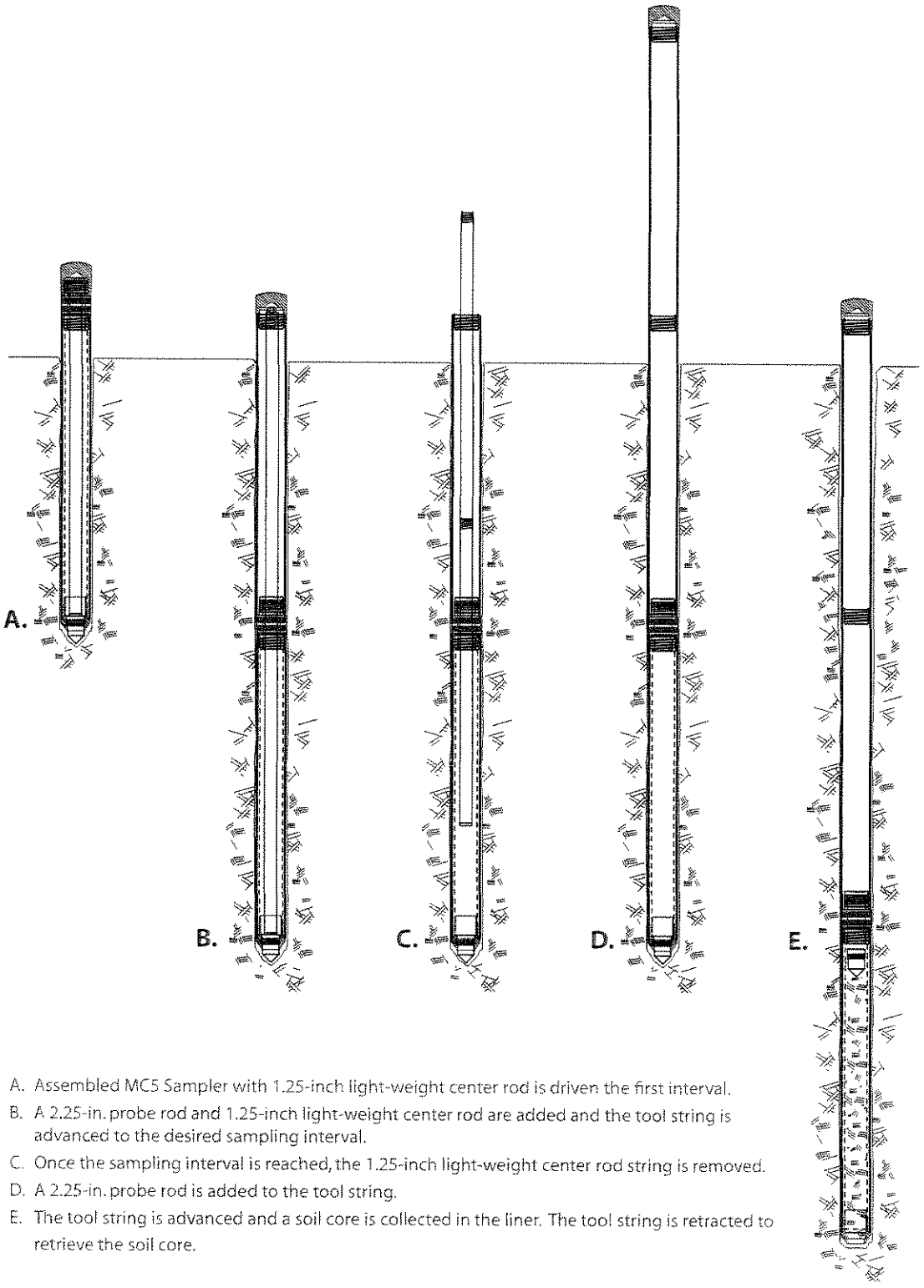
8. Advance the tool string to collect the soil core in the liner (Fig. 4.28E).

   NOTE: Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.

9. Lower the hammer assembly and hook the hammer latch over the pull cap. Raise the hammer assembly to pull the first probe rod out of the ground. Remove the rod and place the pull cap on the next rod of the tool string. Continue pulling probe rods until the MC5 Sampler is brought to the ground surface. If a winch is available, it can be used with a pull plate to retract the tool string. An RG Handle is another option to retract the tool string.

   NOTE: Use caution when advancing or retrieving the sampler within an open hole. Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.

10. Proceed to Section 4.9 for instructions on recovering the soil core from the MC5 Sampler.



A. Assembled MC5 Sampler with 1.25-inch light-weight center rod is driven the first interval.
B. A 2.25-in. probe rod and 1.25-inch light-weight center rod are added and the tool string is advanced to the desired sampling interval.
C. Once the sampling interval is reached, the 1.25-inch light-weight center rod string is removed.
D. A 2.25-in. probe rod is added to the tool string.
E. The tool string is advanced and a soil core is collected in the liner. The tool string is retracted to retrieve the soil core.

Figure 4.28
Phases of MC5 Closed-Point Center Rod System

4.9 Soil Core Recovery

The soil sample is easily removed from the MC5 Sampler by unthreading the cutting shoe and pulling out the liner (Fig. 4.29). A few sharp taps on the cutting shoe with a pipe wrench will often loosen the threads sufficiently to allow removal by hand. If needed, the exterior of the cutting shoe features wrench flats for attaching a wrench to loosen tight threads. With the cutting shoe removed, simply pull the liner and soil core from the sample tube (Fig. 4.31). A Hydraulic Liner Extruder is also available for mounting on your machine to remove liners (Fig. 4.30).

If the closed-point sampler is used, the piston point is now retrieved from the end of the liner (Fig. 4.32). Secure the soil sampler by placing a vinyl end cap on each end of the liner.

Undisturbed soil samples can be obtained from liners by splitting the liner. The MC Liner (AT8010) is used to make longitudinal cuts along the liner (Fig. 4.33).

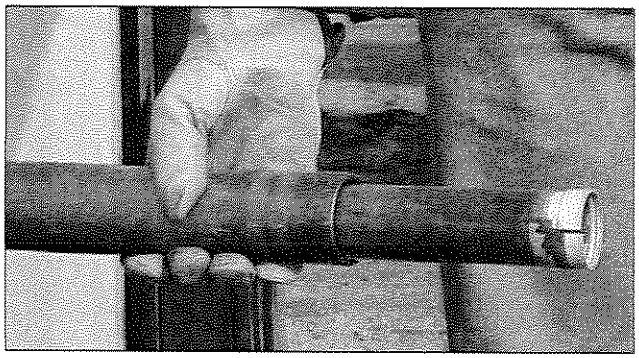


Figure 4.29. Remove the MC5 Cutting Shoe and liner from the MC5 Sampler Tube.

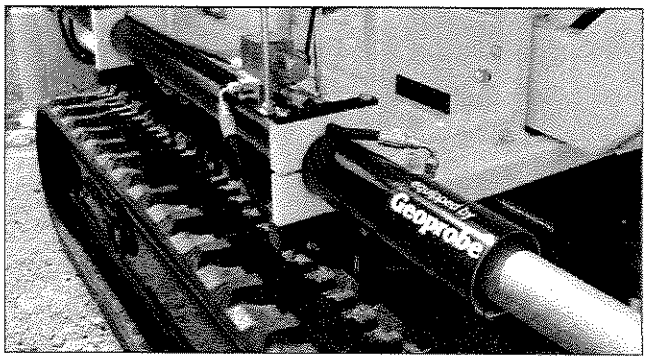


Figure 4.30. The Hydraulic Liner Extruder helps remove the liner.

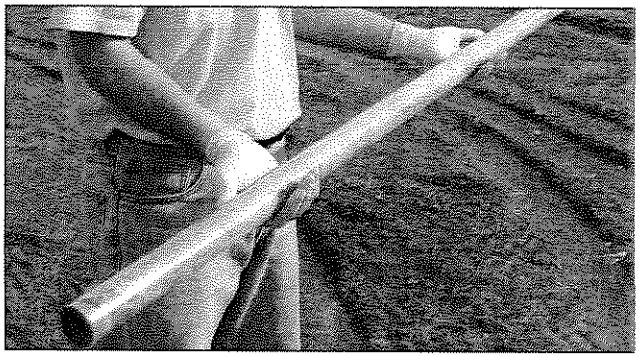


Figure 4.31. MC5 Liner filled with soil core.

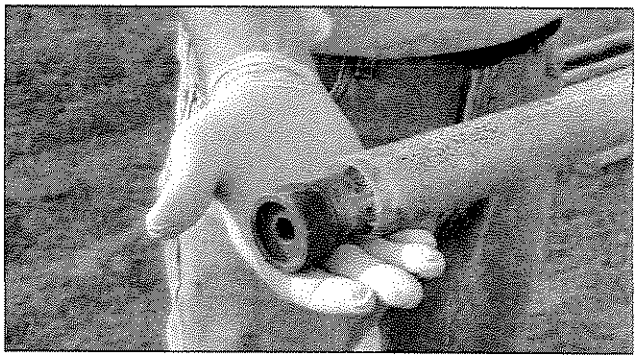


Figure 4.32. MC5 Closed Piston Point is retrieved from the top of the liner.

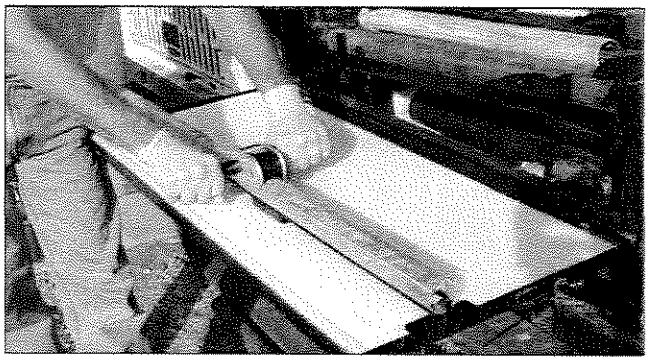


Figure 4.33. MC Liner Cutter makes two longitudinal cuts in PVC Liners.

4.10 Tips to Maximize Sampling Productivity

The following suggestions are based on the collective experiences of Geoprobe® operators:

1. Organize your truck or van. Assign storage areas to all tools and equipment for easy location. Transport sample tubes, probe rods, 1.25-inch light-weight center rods, and liners in racks. Above all, minimize the number of items lying loose in the back of your vehicle.

2. Take three or four samplers to the field. This allows the collection of several samples before stopping to clean and decontaminate the equipment. A system is sometimes used where one individual operates the probe while another marks the soil cores and decontaminates the used samplers.

3. A machine vise is recommended. With the sampler held in a vise, the operator has both hands free to remove the cutting shoe, drive head, and sample liner. Cleanup is also easier with both hands free. Geoprobe® offers an optional machine vise (FA300).

4. Organize your worksite. Practice with the sampler to identify a comfortable setup and then use the layout whenever sampling. A collapsible table or stand is handy to hold decontaminated sampler tubes and liners. Equipment may also be protected from contamination by placing it on a sheet of plastic on the ground.

   Instead of counting probe rods for each trip in-and-out of the probe hole, identify separate locations for "new" rods and "used" rods. Collect the first sample from the open hole using "new" rods. As each probe rod is removed during sampler retrieval, place it in the "used" rod location. Now advance a clean sampler back down the same hole using all of the rods from the "used" location. Add one "new" rod to the string and then drive the tools to collect the next soil core. Once again, remove each probe rod and place it in the "used" rod location as the sampler is retrieved. Repeat this cycle using all the "used" rods to reach the bottom of the probe hole, and one "new" rod to fill the sampler.

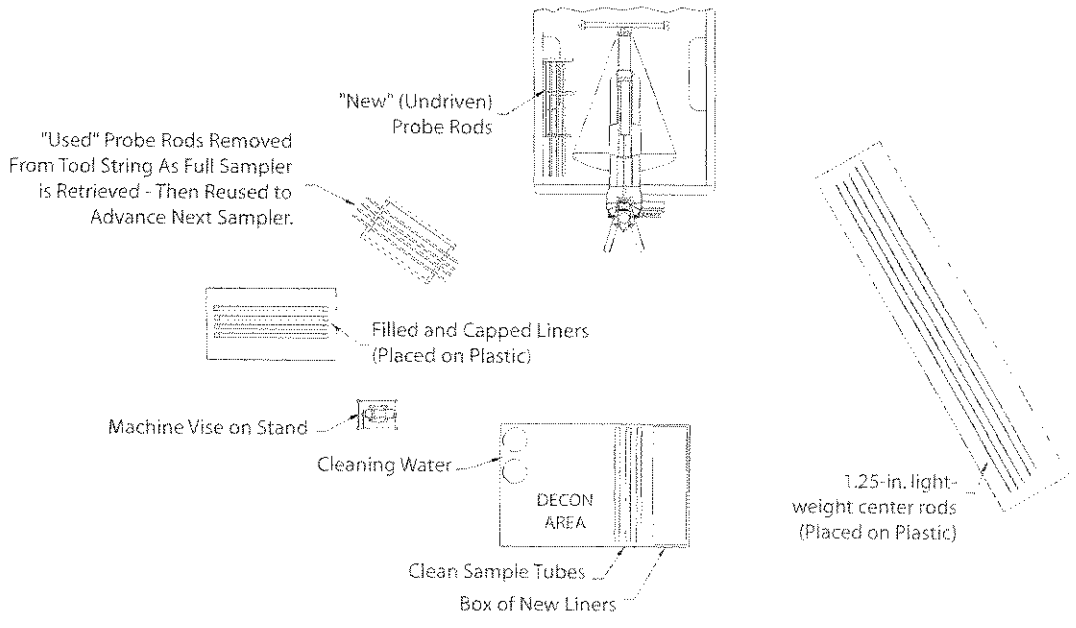


Figure 4.36
Equipment Layout Example to Maximize Sampling Productivity

5. Cleanup is very important from the standpoint of operation as well as decontamination. Remove all dirt and grit from the threads of the drive head, cutting shoe, and sample tube with a nylon brush (BU700). Without sufficient cleaning, the cutting shoe and drive head will not thread completely onto the sample tube and probe rods. The threads may be damaged if the sampler is driven in this condition.

   Ensure that all soil is removed from inside the sample tube. Sand particles are especially troublesome as they can bind liners in the sampler. Full liners are difficult to remove under such conditions. In extreme cases, the soil sample must be removed from the liner before it can be freed from the sample tube.

5.0 REFERENCES

Geoprobe Systems®, 2003. *Tools Catalog, V. 6.*

APPENDIX A
ALTERNATIVE PARTS

Geoprobe® Tools and Equipment	Part Number
Drive Cap, GH40 Series, Threaded, 2.25 in	25362
Drive Cap, GH60 Series, Threaded, 2.25 in	25363
Drive Cap, GH60 Series, Threaded, 2.125 in	15673
Nylon Brush, Macro-Core® Tool	BU700
Nylon Brush, 2.25-in. and 2.125-in. probe rods	BU2125
Extension Rod Handle	AT69
Extension Rod (60-in.)	10073
Extension Rod (48-in.)	AT671
Extension Rod (36-in.)	AT67

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems®.



A DIVISION OF KEJR, INC.

Corporate Headquarters
601 N. Broadway • Salina, Kansas 67401
1-800-GEOPROBE (1-800-436-7762) • Fax (785) 825-2097
www.geoprobe.com